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RECENT CONFERENCES.

THE Conference of Directors and Deputy Directors of Agriculture which took place recently at the Colonial Office was opened by the Secretary of State for the Colonies, and met subsequently under the Chairmanship of his Agricultural Adviser, Mr. Stockdale. Amongst those present were the Directors of Agriculture from Nigeria, the Gold Coast, British Guiana, Malaya, Kenya and the Gambia. The Imperial College of Tropical Agriculture was represented by the Principal, and the Leeward and Windward Islands by Professor Ballou, the Commissioner of Agriculture.

The Conference was essentially of a "business" character and the questions which came before it related rather to the administration of Agricultural Departments, than to the technicalities of agricultural research and experimentation. The matters discussed thus included : the training of agricultural officers and of officers for the subordinate services in Agricultural Departments, the functions of local advisory agricultural bodies, produce inspection, co-operation, agricultural education, the control of pests and diseases, methods of field experimentation and animal husbandry. The systems of records kept at experiment stations and of district registers, and the ways in which Imperial Agricultural Bureaux might render greater service to the Colonial Empire, were also examined.

Special importance was attached to the question of the training of agricultural officers and in this connection it is satisfactory to note that the Conference recorded its appreciation of the high standard that had been attained and that it emphasized the necessity for the continuance of the scholarship scheme. Reference was also made to the risks of jeopardising the success of the scheme if vacancies were not available for scholars and to the importance of providing training in agricultural economics, especially in regard to the economics of peasant agriculture.

General agreement was reached that in the case of most agricultural products, produce inspection and grading were essential if an improvement of quality was to be obtained and if the economic welfare of the producers was to be advanced. It was fully recognised that on no subject was absolute uniformity desirable, or indeed, practicable, but the Directors and Deputy-Directors recorded their conviction that they

had obtained great benefit from the interchange of views at this, the first Conference of its kind, and the hope was expressed that it would be possible to hold similar Conferences in the future as part of the normal machinery for the development of agriculture in the Colonial Empire as a whole.

Another Conference which was held in London recently was the Empire Sugar Conference. This also met for the first time and was called by the Empire Marketing Board to survey the scientific needs of the industry and to bring the whole question of sugar research under review, having regard to the present economic situation. There were about 40 delegates: the United Kingdom South Africa, India, Trinidad, Barbados, British Guiana, Fiji, Mauritius being all represented. The Imperial College of Tropical Agriculture was represented by the Principal, and the Windward and Leeward Islands by Professor Ballou, the Commissioner of Agriculture.

The Proceedings were opened by Dr. Drummond Shiels, Chairman of the Research Grants Committee of the Empire Marketing Board. In his opening address Dr. Shiels reviewed the history of sugar in the British Empire and described the breeding of the new and better varieties of cane in Barbados and British Guiana. He recalled that the latter Colonies had produced canes which were among the highest, if no longer the highest, yielders per acre in the world, and that some of the Barbados seedlings had even been introduced in Java. He then referred to Dr. Barber's work in India in the breeding and classification of canes and the success which had attended the introduction of the Uba variety of cane in South Africa. Further advances had since been made with the result that many of the Empire sugar-growing countries were extending their programmes of research, and one of the objects of the Conference was to avoid overlapping in putting these schemes into operation.

Amongst the subjects discussed at the Conference were the economic aspects of the sugar industry; the desirability of conducting research into the conditions of labour on estates in sugar growing countries, work in respect of which is already in progress at the Imperial College of Tropical Agriculture; sugar-cane breeding and genetics in Trinidad; the development of cane breeding stations in Barbados and British Guiana; the study of soils and fertilisers; biological control and several other matters.

The Conference recommended the establishment of a central cane breeding station in Barbados to serve the West Indies as a whole. Barbados will be invited to meet two-thirds of the cost of this station while it is hoped that the remaining third will be contributed by other West Indian Islands. In view, however, of the present crisis, an attempt will be made to obtain this part of the cost from Imperial funds. The actual breeding work is to be done by the central station while variety trials will be carried out independently in the various islands by the Departments of Agriculture. It was also recommended that the Empire Marketing Board should continue its grant to the British Guiana Station which is carrying out investigations into sterility in canes, the cytology of West Indian varieties and the problem of hybrid vigour.

Proposals were also made for the setting up of a quarantine station for the West Indies at the Imperial College of Tropical Agriculture and for carrying out a scheme put forward by the Government of Trinidad for an enquiry into the fall in soil fertility and into the best methods of improving cane growing practice in the island. The Conference "considered it essential that each Government concerned should enquire into the conditions affecting the efficiency of labour in the sugar cane industry". It further suggested that investigations should be conducted into the relative efficiency of large and small units of cultivation. Research on the improvement of agricultural methods, the better interchange of information and the exchange of workers, were aspects of scientific work which it was desired to see extended. The work on the biological control of insects is to be continued and recommendations were made that it should be extended to Empire countries as occasion demanded.

The Empire Marketing Board is to be congratulated on its initiative in convening this first Empire Sugar Research Conference. By bringing together some of those best qualified to speak on the problems examined some very useful results were obtained while the co-operative objects for which the Conference was mainly held were also achieved.

ELECTRICITY IN HORTICULTURE.

ELECTRICITY is at present little used in horticulture, but since market gardening is usually carried out on intensive lines and in concentrated areas, there seem better prospects of its proving an asset in this industry than in farming. In a recent article (*Jour. Min. Agric.*, 38, p. 132), C. A. Cameron Brown shows that a considerable amount of experimental work on this question is being undertaken, some of which seems suitable for development on a large scale. Electricity as a source of bottom heat appears to be particularly promising. Electric hot-beds are already employed successfully on the Continent, and it is not improbable that an extension of this system would lead eventually to some replacement of the usual manure hot-bed with its obvious disadvantages. The investigations regarding the use of power of cultivation, and electric light for increasing plant growth are less far advanced. Various cultivation implements have been designed, notably in France, but their cost of production is at present too high to merit their use on a commercial scale. Extension of the length of day by artificial lighting has been definitely shown to improve the growth of plants, but more experiments are required before it is certain that such treatment can be considered an economic proposition.—(*Nature*, Vol. CXXVII, No. 3217.)

BANANA DISEASES.

I.—Observations on Botryodiplodia Fruit Rot of the Banana.

By C. W. Wardlaw,

Low Temperature Station, Imperial College of Tropical Agriculture.

1. Introduction.

Botryodiplodia theobromae Pat. is well known in the Tropics as a wound parasite on a considerable range of host plants. Research in Trinidad has shown it to be an important parasite on the banana in storage, since it is not only responsible for a rapid downward rotting of the main-stalk of the whole bunch, but it also causes finger-dropping, fruit spots and blemishes and an extensive tip-rot on several of the more important varieties.* It has also been described by Ashby (1) in relation to a disease of suckers. Since the organism is capable of very rapid growth at normal temperatures, it may cause considerable rotting of the mainstalk in the course of a few days. Under the usual trade conditions for transporting fruit to the English market from Caribbean plantations (*i.e.*, at a temperature of approximately 53°F. during the voyage of about 16 days and subsequent ripening at 70°F.) the activity of this fungus can be kept sufficiently in abeyance provided rapid cooling of fruit to 53°F. has been adopted (5). On the other hand, if infected fruit is ripened at normal temperatures, if the period before loading is prolonged, or if rapid cooling immediately after loading is not carried out, or again if the storage period at the lower temperature is an extended one, a considerable amount of rotting may ensue. (5, 6.)

As this disease has apparently hitherto received little attention in banana literature the following account of investigations has been prepared.

2. Occurrence.

Several banana tip-rots (*i.e.*, decay of the fruit from the perianth end backwards) and fruit rots in general are known (5, 6, 7); of these, fruit rot caused by *Botryodiplodia theobromae* Pat. probably represents the most severe type of infection, though it is apparently less common than that due to *Gloeosporium musarum*. A description has been given by Sydow and Butler (4) of an organism named *Diplodia musae*, Died. which was obtained from dead fruits of *Musa sapientum* in Assam. In a later section it will be seen that this fungus is probably identical with *Botryodiplodia theobromae* Pat.

The first specimens of *Botryodiplodia* tip-rot were obtained in our ripening rooms at the end of some long-storage trials (24 days at 52.5°F. and six to eight days at 70°F. in contrast to the usual 16 days at 53°F. and six to eight days at 70°F.) when a characteristic decay made its appearance on the Gros Michel, Cavendish and Lacatan varieties. In contrast to the localised disease effects which normally follow mechanical injury to the lower side of the fruits, this tip-rot was evenly developed all round and appeared to have originated in or immediately below the decayed perianth or style; from there it had spread uniformly along the fruit causing a progressive brownish-black discolouration of the skin. This disease, which becomes prominent as the fruit is approaching maturity, may sometimes affect two-thirds or even the whole of the finger, the flesh being rendered soft and pulpy and finally semi-liquid, with a sweetish odour. At the same time the skin becomes soft, black and wrinkled, and encrusted with pycnidia. Wounds and blemished areas may also become infected and give rise to extensive decay. According to the humidity of the atmosphere the characteristic greyish-green mycelium may also be observed here and there on the skin.

When the infection progresses at a higher temperature (*e.g.*, room temperature of 80° to 85°F.) and with high humidity as in a closed container, pronounced rotting takes place in the course of ten days. Under such conditions the fungus grows abundantly over the skin forming a dense felt-like weft sometimes 0.5 to 1.0 cm. thick, the fruit flesh within being thoroughly exploited and hollowed out, while later on large fructifications make their appearance. If the infection is allowed to proceed at the same temperature but not enclosed, superficial hyphae are less in evidence.

Reaped fruit may apparently be attacked at any stage, depending on circumstances. Thus, small fingers on fallen immature bunches of the Lacatan variety have been found highly infected, the fruits being completely decayed and covered with a crust of pycnidia. Fig. 1 shows a typical tip and finger-stalk infection of "half-full" Lacatan fruit stored in "hands" in the laboratory at normal temperatures. Occasionally very immature fruits of the Cavendish variety (Trinidad Governor) become affected in the field. A shrivelling and blackening of the fruit either at the stalk or distal end may take place. The disease as a rule does not spread to other fingers (unless the cushion is affected) and after some time, small, hard, blackened fingers are to be seen in the midst of the normal healthy green ones. Mature fruits of practically all varieties under observation, including seeded forms, have also been found with some *Botryodiplodia* infection.

When inoculation experiments were carried out under different storage conditions, the variable results obtained indicated that the extent of infection depended on a number of factors, such as maturity of fruit, pre-storage history, method of storage adopted and the accompanying temperature and humidity relations. As the fungus is capable of causing very considerable wastage in stored fruit, it is important that the precise conditions under which effective parasitism takes place should be more accurately

* The individual banana fruit may conveniently be described as a "finger," and its short stalk as the "finger-stalk;" where several "finger-stalks" meet constituting a "hand," a crecentric "cushion" is formed. These "cushions" project from the "main-stalk" of the whole bunch.

ascertained with a view to curtailing loss. A series of inoculation experiments is accordingly being carried out, the results of which will be discussed in a later work.

3. Inoculations in the field.

Apart from the inextensive damage to young Cavendish fruits described above, *Botryodiplodia theobromae* has not been observed as an active parasite in the field on hanging bunches. It seemed desirable, however, that field inoculation experiments should be carried out. Accordingly, fruits of different ages, from very young to "half-full", were wounded in various ways, by stabbing with a needle, by making small cuts with a scapel, and by breaking off the perianth remains. The fungus was applied to the wounds in the form of spores and pieces of mycelium on an agar medium. In addition, wounds were made in the main-stalk and inoculated. Inspection was carried out regularly until the bunches were ready to be reaped; negative results were obtained throughout. When the several types of wound were examined it was found that a corky layer had been formed by which fungal invasion was effectively checked. These observations, made during the dry season, indicate that *Botryodiplodia theobromae* is unable to cause disease when applied to slight wounds on hanging fruit. Since occasionally young Cavendish fruits do become diseased it is possible, under special weather conditions or particular conditions of injury, that some infection could be produced in the field.

4. Disease in relation to storage.

The method adopted for investigating disease of fruit in storage was as follows. Bunches, representing different degrees of maturity, were cut up and sound hands selected. These were sterilised superficially by washing in 0.2 per cent. mercuric chloride solution for five to ten minutes, after which they were washed in two changes of sterilised water and transferred to aseptic desiccators of 28 litres capacity. Inoculations were carried out by scratching the surface of fingers at the apex, midway or on the finger-stalk, with a needle, the fungus being then applied in the form of spores or pieces of mycelium on an agar medium. It had previously been ascertained that the fungus did not penetrate the unwounded fruit skin. Each desiccator was supplied with a small vessel containing soda-lime to take up the carbon-dioxide of respiration. As explained elsewhere (5), with the exception of the higher humidity inside the containers, the atmosphere otherwise was comparable to that of the storage rooms when charged with fruit.

At the temperature of the laboratory (80° to 85°F. approximately) positive results were consistently obtained on both young and mature fruits, the disease effects being more rapidly produced and more marked on the latter. After three to five days it could be seen that the fungus was penetrating at all the points of inoculation, while at the end of ten days rotting of the fruit was well advanced. When specimens of inoculated fruit were examined from day to day and compared with uninoculated controls, it was observed that the penetration of the fungus resulted in an acceleration of the ripening processes. Thus after a few days, it was found that, while uninoculated fruit still gave a starch reaction when split open and treated with iodine, the inoculated specimens, whether relatively immature or full fruit gave no reaction; in other words the presence of the fungus caused a premature breakdown of the starch into sugar. At first sight it appeared as if this might be related to the diffusion of diastase from the tissues which had been penetrated by the fungal hyphae, since it was known from cultural experiments that *Botryodiplodia theobromae* can secrete this enzyme in considerable quantities. It was found, however, in the case of immature fruit, that the region actually traversed and killed by hyphae still contained starch grains, while tissues remote from the inoculum had undergone premature ripening. These, together with other observations on the extent of fungal penetration, indicated that the acceleration of saccharification processes, while definitely related to the presence of the pathogen, could not be referred to the direct action of enzymes diffusing from it. Similar effects are known to be produced by other parasites, *e.g.*, *Thielaviopsis paradoxa* (5); this will be the subject of further investigation. In the experiments described above the active nature of the fungus as a parasite on fruit stored at high temperatures was established.

When inoculated hands were kept at the higher temperature of the laboratory for a few days before transference to 53°F., the start which the fungus had been able to make resulted in the production of varying amounts of disease before the usual period in cool storage and subsequent ripening had elapsed. In practice, then, if fruit has become infected between the time of reaping and cooling to 53°F. in the ship's hold, the amount of time that elapses between the two processes (reaping and cooling) will be of fundamental importance in determining the extent of subsequent wastage caused by this organism. In the larger companies, where organisation has reached a very high standard of efficiency, the time between reaping and loading is only 36 hours. Where the organisation is less efficient this period may be considerably increased thereby rendering the fruit more subject to attack. Slow cooling after loading operations are completed, likewise tends to increase the amount of disease.

In order to determine the length of time at normal (outdoor) temperatures required to start off the fungus so as to produce a significant amount of disease before the usual periods in cool storage and ripening rooms have elapsed, a number of experiments are now being carried out.

5. Penetration of tissues.

(*a*) *In cool storage fruit.*

The initial stages in the penetration of the tissues of the fruit skin were determined from microtome sections cut parallel to the long axis of the fruit and taken at the junction of diseased

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FIG. 1.

Finger-stalk and tip-rot of the Lacatan banana stored in hands at laboratory temperature—(x 2/3).

FIG. 2.

"Botryodiplodia theobromae" growing in pure culture showing the large fructifications—(x ½).

FIG. 3.

Two examples of the large stromatic fructifications of "Botryodiplodia theobromae" obtained from synthetic sucrose media. The upper specimen shows a stroma with embedded pycnidia, seen from above—(x 6).

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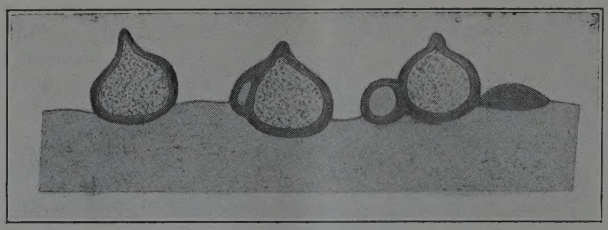

FIG. 4.
Section through a diseased banana skin showing the characteristic separate, flask-shaped pycnidia—(x 50).

FIG. 5.
Hyphae of "Botryodiplodia theobromae" during the initial stages of infection of the skin (during cool storage), traversing the tissue by penetrating the middle lamellae and cell walls. (c. w.)—(x 1,000.)

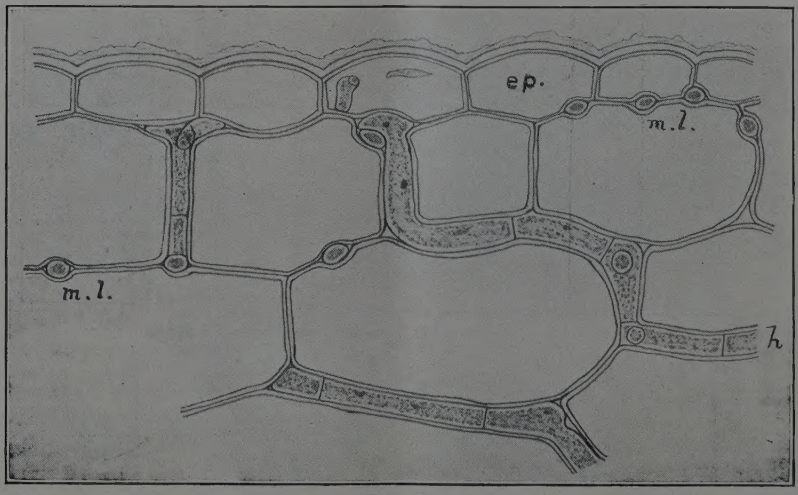

FIG. 6.
Affected tissue of the skin showing characteristic penetration of the middle lamellae (m.l.) by hyphae (h) ; Epidermis (ep.) ; (during cool storage)—(x 1,000).

and healthy tissue. The sub-epidermal tissues are relatively compact so that the air spaces are correspondingly small. It is in the latter but more especially in the middle lamellae that the first of the advancing hyphae are to be observed. Characteristic stages in the passage of hyphae through the tissues are illustrated in Figs. 5 and 6, where it will be seen that the middle lamella is the seat of the major activities. As a general disintegration of the cellular skeleton does not take place, it may be inferred that the penetration of the middle lamella depends on the localised secretion of a pectinase enzyme round the hyphal tip, and not on a more general diffusion of enzymes in advance of the hyphae. Frequently the action of the secretions on the middle lamellae was marked by a localised swelling of the walls. From these advancing hyphae occasional slender filaments pass through the cell walls into the cell contents, Fig. 5. Proceeding towards the older infected zone, fungal activity is accentuated, and soon most of the cells are surrounded or partly surrounded by hyphae while at the same time the cells are penetrated by slender filaments. In the vicinity of stomata where the intercellular air spaces are larger, the fungus is considerably more in evidence and here and there aggregates of short, stout, dense hyphae constitute the primordia from which pycnidia will ultimately be formed. The first traces of pycnidia may thus be observed at a distance of about one cm. behind the furthermost point of invasion. In the older stages of infection hyphae of much larger diameter and of a dark brown colour are conspicuous in the tissues. At some points the cells of the skin including the epidermis become freely invaded by numerous slender filaments; at other points fungal invasion consists mainly in the presence of stout hyphae in the middle lamellae. The inner tissues of the fruit skin show the same general features, but as the cellular construction is more open the presence of hyphae is more marked than in the sub-epidermal cells. The final result of fungal invasion is a complete killing of all the tissues of the fruit skin. While the cellular skeleton shows little actual disintegration, except where pycnidia are being formed, the absorption of cell contents by the fungus is reflected in a general shrinkage of tissues accompanied by the characteristic wrinkling of the skin.

The flesh within is very thoroughly exploited and is finally reduced to a semi-liquid condition. The same general type of hyphal activity as that already described is to be observed, but here the filaments show very strong, coarse growth, Fig. 7, and are consequently very conspicuous. Here again the middle lamella is the seat of the earlier penetration but extensive intracellular hyphal activity is also present from an early stage.

(*b*) *At normal temperatures.*

At normal temperatures the progress of the disease is much more rapid. The same type of tissue invasion was found as in fruit attacked during cool storage, the middle lamellae again being penetrated to a very marked degree. The hyphae involved, however, were of a much coarser texture and of considerably larger diameter than those already described, a common feature of sections being the way in which parenchymatous cells were thrust apart by the presence of several stout hyphae massed together in the middle lamellae, Fig. 8. Some infected tissues showed a very marked penetration of the cells by numerous small branched hyphae, while in other material this was less noticeable.

6. The Fungus.

Botryodiplodia theobromae is already well known to pathologists and need not be described here at length. The question of synonymy in this species has been fully dealt with by Petch (3) and Nowell (2). The fungus is readily obtained in pure culture from affected fruits by taking pieces of infected tissue from within or spores from the surface of the rind. On suitable nutrient media, especially those containing high concentrations of starch or sucrose, numerous large fructifications are obtained, each consisting of a stroma of matted hyphae with a few or many embedded pycnidia, Figs. 2, and 3. On the surface of infected banana fruits, however, such large fructifications are not produced in the absence of high atmospheric humidity, and microtome sections show the pycnidia to be regular, rounded, flask-shaped structures, separate or grouped together, Fig. 4, and as a rule placed superficially or only slightly immersed. Each pycnidium has a short straight neck and ostiole, dark carbonised outer walls and a diameter of 250 to 300 μ, while within the conidia are borne on short conidiophores accompanied by paraphyses. The conidia appear to be mainly extruded as single cells and subsequently mature to the characteristic brown, uniseptate, unconstricted, conidia, measuring (average) 25 × 15 μ. The description of *Diplodia musae* Died. made from pycnidia occurring on dead fruits of *Musa sapientum* in Assam (4) suggests that it may be synonymous with *Botryodiplodia theobromae*. The pycnidia of *Diplodia musae* are described as densely gregarious, more or less immersed ostiolate, 200 to 300 μ in diameter, spores at first hyaline then uniseptate and brown, not constricted and measuring 17 to 20 × 10 to 13 μ. The spore measurements are admittedly lower than those obtained in Trinidad but the two descriptions show many points in common. The matter could readily be settled by preparing cultures from the Assam material.

Various experiments carried out on the growth of *Botryodiplodia theobromae* on different media showed that it has a great capacity for utilising carbohydrates, and that it can grow rapidly in high concentrations of starch and sucrose. These facts, together with the observation set out above regarding its power of penetrating tissues, contribute towards an explanation of the rapidity with which it exploits the banana in storage.

7. Summary.

1. *Botryodiplodia theobromae* Pat., an important parasite on the banana in storage, causes rotting of the main-stalk, finger-dropping, fruit spots and blemishes, and an extensive tip-rot on several commercial varieties.

2. The fungus rapidly exploits the fruit, the flesh being rendered soft and pulpy or semi-liquid, while the skin becomes dark coloured, wrinkled and covered with a crust of small black pycnidia.

3. Field inoculations on hanging fruit consistently yielded negative results.

4. The fungus is essentially a wound parasite.

5. At laboratory temperatures (80° to 85°F.) and in presence of adequate humidity, disease effects are quickly produced on inoculated fruits, whether relatively immature or "three-quarter full", premature ripening being a characteristic feature.

6. The period of time that elapses before inoculated fruit is placed in cool storage is of fundamental importance in determining the extent of subsequent fungal activity. In large consignments of fruit, therefore, one aspect of the control of this disease will depend on curtailing to the minimum the time between reaping and cooling down the cargo in the holds to 53°F.

7. A detailed account is given of the behaviour of the fungus in the tissues. The hyphae penetrate chiefly through the middle lamellae but they also pass freely from cell to cell.

8. The fungus isolated is in close agreement with previous descriptions of *Botryodiplodia theobromae*. Pat. On the surface of the banana the fructifications consist of small separate pycnidia; it is suggested that a species *Diplodia musae* Died. described from Assam may be identical.

9. The activity of this fungus on the banana is to be attributed to its intrinsic high rate of growth and to its very considerable capacity for utilising carbohydrates, even when they are present in high concentrations.

The writer is much indebted to Professor E. E. Cheesman and to Professor H. R. Briton-Jones for technical facilities kindly provided by them.

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SOIL EROSION IN CEYLON.

The problem of soil erosion has recently been investigated in Ceylon by a Committee representative of revenue, agricultural irrigation, forestry, survey and planting interests. Exhaustive enquiries were made into the problem as it exists in Ceylon to-day, by visits to all important planting districts and inspection of agricultural and irrigation works, village settlements and forests clearings. The Committee in its Report enumerates at length the measures taken to combat soil erosion on various forms of cultivation (tea, rubber, *chena* cultivation, &c.) and also describes the external evidence of erosion in the silting of estates and paddy fields, the damage to irrigation works, roads, and railways and the silting and flooding of rivers. Regarding "soil erosion as being caused primarily by the free movement of water on the surface of the ground," the Committee considers that ground covers are of supreme importance and should provide the key to the solution of the problem. The objections raised to the use of ground covers are shown largely to be the result of prejudice or ignorance. Soil treatment is considered to be of importance if properly done, but shade, terraces, and leguminous hedges are looked upon as of being only of limited value. Drastic revision of drainage ideas are needed as drains should be regarded only as a second line of defence against soil erosion, rather than as a means of leading the water off the land by the shortest and quickest route. The tendency shown in recent years towards flattening the gradient of drains is encouraged, and it is stated that the provision of silt pits and locks is essential if the drains are to fulfil their proper functions of holding up the water until a maximum amount may be absorbed, and of removing from it any silt which other means of soil conservation may have allowed to be removed.

The Committee criticizes the present method of treatment of new clearings which aims at establishing a record time in which the crop may begin to yield, rather than that of favourable conditions for growth from the beginning.

Among its recommendations, the Committee states that the first and most important step in the control of erosion should be the provision of ground cover. It also advocates that education and propaganda should go hand in hand with research into methods of soil conservation, but thinks that the safeguard against erosion which it recommends are so basically sound that they should be adopted at once. It defers the question of introducing legislation for enforcing measures of soil conservation to the time when such compulsory action may be found necessary, and if improvements fail to take place as a result of the publication of the Report. It recommends, however, that immediate steps should be taken to introduce legislation with regard to external damage, *i.e.*, damage to property other than that on which the erosion takes place.

THE CULTIVATION OF YAMS.

(*Concluded.*)

By D. H. Brown.

Staking.

Staking is definitely desirable, but it is to some extent bound up with the question of weeding. It is stated (12) that weeds do more damage among unstaked than among staked yams, and an extra weeding may be required. The following figures from a three years' trial give some idea of the value of staking and of additional weeding.

	Yield in tons per acre.			
	1st Year.	2nd Year.	3rd Year.	Average.
Unstaked	3.21	3.96	3.88	3.68
Staked	5.74	6.49	5.55	5.92
Unstaked but receiving extra weeding	..	..	5.28	5.28 (1 year only).

The use of stakes cut from the neighbouring bush for the purpose of yam props has already been dealt with. In countries which are further developed and more thickly populated it is obvious that the provision of suitable stakes in the quantities required may raise something of a problem. In Trinidad, bamboos grow fairly plentifully and these, when obtainable, make excellent props; the main stems are used, the foliage being removed, and the side shoots cut back to about one to two feet; these are usually provided at the rate of one stake to every two plants. Where weaker and more slender stakes have to be used a good plan is to use one stake per plant and to tie together the stakes in fours at a height of about six feet so that the four stakes then form a pyramid, the corners of the base being four hills.

The disadvantage attached to this practice is that the future use of animal drawn implements for intercultivation is prohibited between alternate pairs of rows, but there is no doubt that it enables one to utilise poor quality stakes which, if allowed to stand alone would be useless.

Another method of staking lies in erecting a trellis of horizontal slats above the row of yams, or between adjacent rows instead of placing a single vertical stake to each hill. Quite apart from the availability of material, the labour involved in collecting and setting up stakes is a very heavy item of cost, and the trellis method has been found to economize considerably in both directions (1), the cost of labour being reduced by 50 per cent. The upright posts for the trellis should be about 12 feet apart and the horizontal slats consist of bamboos split into four pieces.

Although this method of staking enables one to make best use of a limited amount of material and also to cut down costs, yields in general are not up to those obtained from a crop grown on vertical stakes. The following are the results of a trial of staking methods in the Philippines on nine different varieties planted with a varying number of sets per hill.

Number of tubers per hill.	Number of varieties giving best results on vertical poles.	Number of varieties giving best results on horizontal trellis.
2	7	2
3	6	3
4	8	1

The results of the same experiment expressed differently are as follows:—

With two tubers per hill verticals showed 15 per cent. increased yield over horizontals.

With three tubers per hill verticals showed nine per cent. increased yield over horizontals.

With four tubers per hill verticals showed 35 per cent. increased yield over horizontals.

In cases where staking material is scarce or does not exist in a wild state, it is often convenient to plant an area of land with something suitable for cutting to supply yam props. This is particularly to be recommended where the area of yams cultivated is roughly the same year after year. Under these conditions the size of the prop plantation can be designed to satisfy the requirements of the yam area, and the two can be run on systematic lines.

The most suitable plant for this purpose is probably *Gliricidea maculata*. This is easily established and grows rapidly. Cuttings about three feet long taken from one year old branches, should be planted 18 inches apart in rows spaced at six feet intervals. The site of the *Gliricidea* plantation should be prepared by a thorough ploughing and the cuttings properly planted by digging a hole, inserting the cutting and replacing the soil around it; it is not sufficient merely to push the cutting into the soil—a common practice—if the best results are to be obtained.

The best planting season is the beginning of the rains. The cuttings take root readily and soon produce shoots, most of which grow from near the top of the cutting; in one year these grow to sufficient size to provide useful stakes so that an annual cutting can be made hard back to the original plant.

After the first season each stool should produce about ten good stakes annually so that from an acre we obtain 48,400 stakes. Yams planted at five feet by two feet represent 4,356 hills per acre so that under these conditions for each acre of yams 0.09 acres of *Gliricidea* will be required.

When using the stakes it is advisable to adopt the method already described of tying together the top of every four adjacent stakes. The vines may require assistance in twining on the stakes in the early stages, but they will soon be able to take care of themselves. This remark applies equally to other methods of staking.

During the past season at the Imperial College of Tropical Agriculture an interesting series of plots was laid out wherein various methods of staking were demonstrated. The yams were planted two feet apart in the ridges, the latter being three feet apart and the notes below describe the systems of staking and observations made on the different methods.

1. Bamboos standing seven feet above ground level having their side branches cut back to about twenty inches were provided at the rate of one stake to two plants. The stakes were placed in one side of each ridge, each stake being equidistant from the two plants whose vines it was to support, the side branches being in a line parallel to the rows.

O O O O O O O O
X X X X

O O O O O O O O
X X X X

O=Plants. X=Stakes.

2. Similar bamboo props were erected but in half the quantity—*i.e.*, one prop per four plants. These were placed in the centre of every alternate furrow with their branches at right angles to the rows.

O O O O O O O O
X X X X
O O O O O O O O

O O O O O O O O
X X X X
O O O O O O O O

O=Plants. X=Stakes.

3. *Gliricidea* stakes up to twelve feet in height were erected between every alternate pair of plants in a similar manner to the bamboos in section 1. The stakes were bent over and tied together in fours at a height of six feet, for the purpose of providing additional strength.

4. Bamboo trellises were built in the centre of every alternate furrow. The trellis consisted of stout bamboo uprights six feet high spaced eight feet apart with cross rails made of split bamboos and lighter branches.

5. No stakes were provided but maize was interplanted in the side of each bank, three seeds to each stand, later thinned to one plant each. The stands were twenty inches apart along the bank. Maize planting followed immediately after that of the yams so the latter, as they grew, were encouraged to twine and climb on the maize stalks.

Observations.

During the early stages of growth the plants climbed best on the *Gliricidea* and maize. These supports being considerably thinner than the bamboos, the young yam shoots were better able to commence twining. Later, when the vine had reached the top of the taller *Gliricidea* stakes, these became "top heavy" and broke off at ground level. This remark does not apply to those stakes (about 25 per cent.) which took root and sprouted. The shorter stakes—up to seven feet in height—withstood the weight of the vines successfully. In patches where the supports gave way weeds grew vigorously whereas under the shade of the supported vines the land remained clean.

A crop of corn was collected from the plot interplanted with maize. Soon after harvesting the cobs, the stalks gave way but, unlike the *Gliricidea* which collapsed at ground level, many maize plants tended to break at a height of about three feet. The remains of the stalk, therefore, continued to furnish some support for the yams. Weeds became prominent in this plot following the breaking of the maize It is recommended that where this method of supporting is in practice the stalks should be broken deliberately by hand at a height of three feet at the time of reaping the cobs; this would result in a greater final stand of maize plants.

Where bamboos were used, weeds were kept in check by shade although the upright props were more effective in providing this than was the trellis. In the latter cases the young vines required a good deal of "training" but having once made a start they grew well. Upright bamboos gave more satisfactory results. Under the dry conditions which prevailed during the season, the yam vines did not grow luxuriantly and one stake to every four plants appeared to be all that was necessary; under conditions of more vigorous growth it is doubtful if this would be sufficient to give optimum results.

INTER-CULTURE.

The next point which arises is the matter of inter-cultivation. The amount of cultural work necessary during the growth of the crop will depend upon the prevalence of weeds and the type and general condition of the soil. Little need be said about it; hoeing by hand or with animal-drawn implements will check weeds and help to keep a heavy soil open. On lighter, sandy land, the banks will tend to become washed down more readily and these must be moulded up at intervals with a ridging plough or by hand. Care must be observed that the plants do not become damaged, particularly when working with implements.

RIPENING.

With the dry season the crop matures and gradually the leaves and vine die off, the period during which the crop resists the drought varying with different varieties.

Harvesting.

When reaching this stage of maturity, the crop may be lifted. It is important, if the produce is to be stored, that harvesting should not be attempted before the tubers are fully ripe, for an immature yam will display indifferent keeping qualities. On the other hand, so long as the weather remains dry, the tubers will not deteriorate if left in the soil, in fact it is probable that the most effective store is the place in which they grew.

The date of reaping may, therefore, be any time during the dry season and it will be governed by the use to which the crop is to be put, the use which is to be made of the land, storage accommodation, labour supply and so on.

The method of lifting will depend upon circumstances. Deeply rooting varieties will call for different tools from those used for shallow rooters, similarly the condition of the soil, which in most cases is hard at such a season of the year, will influence one's choice. Under primitive conditions the grower will use his short-handled hoe and the blade of his cutlass for the work, elsewhere picks, mattocks and forks will be more in evidence. In any case the work is usually performed by hand-labour; attempts to lift the yam crop by the use of animal drawn implements have failed for one reason, namely that by such a process the tubers are unavoidably damaged by cutting and bruising, thus considerably reducing their storage capacity.

Storage.

Under suitable conditions yams will keep in excellent condition in store, and many varieties may be saved until the harvest of the following year's crop without undergoing any considerable deterioration. It must not be assumed on account of this that the produce may be treated carelessly, for in such a case there will be a large amount of wastage or even the whole crop may be spoiled.

It is important that the tubers be thoroughly mature before harvesting is attempted and the necessity for observing the utmost care to avoid damage during lifting operations has already been mentioned; it is, however, not out of place to lay stress on this point again here. Similarly the tubers must not be bruised in handling between the field and the store. Tubers which have become cut or otherwise damaged should be used or disposed of as soon as possible, but if they must be stored, bruised parts should be cut out and the cut surfaces should receive treatment to prevent the introduction of decay. Air-slaked lime is commonly used for this purpose, but Bordeaux mixture, applied as a dry powder, has been found to give better results. It was found (7) that where rotting occurred in 88 per cent. of untreated cut tubers, among similar tubers treated with slaked lime, the figure was reduced to 40 per cent. and with Bordeaux mixture to 16 per cent. In order to elaborate the comparative efficiency of the treatments, the trial was deliberately carried out under conditions which invited decay.

It is desirable that the place of storage should be airy. A building provided with shelves on which the roots may be placed in layers, not more than three or four deep, is convenient and in such a place the yams should keep in excellent condition. It may so happen that the only practical method is to pile the roots in a heap, and under these circumstances the heaps should be kept as small as is reasonably possible; the roots should be picked over from time to time and examined for any signs of rotting. Storage in pits in the ground is not to be recommended unless the soil is thoroughly dry and likely to remain so.

The general remark that yams keep well in storage has been made, but it must not be overlooked that some varieties are superior to others in this respect. For instance, it was observed that of the eleven varieties grown at the Imperial College of Tropical Agriculture in 1930-31, Eboe and Guinea tended to throw out shoots more readily than any of the others during storage, while Horn showed symptoms of being more liable to attack by scale insects.

Fungous and Insect Pests.

The yam is remarkably free from fungous attack and there are few diseases recorded as being responsible for primary damage to this crop.

Nowell (28) describes a "leaf blotch" caused by *Cercospora* in Trinidad in which the symptoms take the form of large black patches on the leaves. "Wilt" diseases which occur in some of the other West Indian Islands can possibly be connected up with root disorders, while of a "Tuber Rot" several times reported from Antigua little information is available.

With regard to insects in Nigeria in recent years, the Dynastid Beetle, *Heteroligus claudius*, has done considerable damage in the three provinces, Onitsha, Benin and Benue, in the last of which it was responsible for famine conditions in the yams in 1926 and 1927. It has been found possible to avoid this pest by planting later in the season than is customary, but this has the disadvantage of giving but a small yield (26). Investigations are being continued in the hope of finding more suitable control measures.

Professor Ballou, Commissioner of Agriculture for the British West Indies, supplies the following information "Several weevils, the sweet potato weevil (*Euscepes batatae*), the root borer of sugar-cane in Barbados (*Diaprepes abbreviatus*) and related forms in other West Indian Islands, a yam weevil in Jamaica, and some scale insects, the yam scale (*Aspidiotus hayti*) in the West Indies and the coffee Mealybug (*Pseudo-coccus lilacinus*) in Kenya are given as pests of yam.

In the West Indies, the Yam Scale is sometimes a very serious pest. It continues breeding on the stored roots, causing them to shrivel and if infected pieces are planted, the young scales swarm on the shoots and cause their death."

Disinfection with carbon bisulphide of tubers to be used for planting has been recommended in connection with yam scale.

Yield.

It is obviously impossible to attempt to estimate the average yield from yams grown under mixed cultivation; grown on a large scale and as a "sole" crop yields vary according to soil and weather conditions, treatment and variety. This variation may be so wide that here again an estimate of an "average" crop would be useless. It will suffice, therefore, to quote a few typical examples.

TRIAL OF FIVE VARIETIES FOR 3-5 YEARS IN VARIOUS WEST INDIAN ISLANDS (12).

Variety.	Yield in lb. per acre.		
	St. Vincent	Barbados	Trinidad
Light Red ..	51,926	11,908	46,282
Red	27,895	..	43,015
Horn	26,625	6,012	21,235
Seal Top ..	19,385	4,980	46,827
Bottle Neck Lisbon	19,285	12,000	20,691

FIGURES FOR MALAY (10).

Twenty-two varieties of *D. alata* yielded from 6,100 lb. to 31,020 lb. per acre, with an average of seven tons. Average yield per plant: three pounds.

Three varieties of *D. esculenta* gave from 13,530 lb. to 25,080 lb. per acre, with average of 7.8 tons. Average per plant: three pounds.

Corresponding figures for the following year were (13):—

D. alata 6,600 to 37,950 lb. Average 7.4 tons.
D. esculenta 12,370 to 21,950 lb. Average 7.7 tons.

TRINIDAD—IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

1930	....	.... 19,039 lb. per acre.
1931	....	.... 25,598 do.

Cost of Production.

For purposes of comparison, labour "costs" are best expressed in terms of time.

A crop (on 0.6 acres of experimental plots) grown at the Imperial College of Tropical Agriculture in 1930-31 gave the following figures:

	(Days Worked. Per acre).				
	Man.	Woman.	Child.	Mule.	Ox.
Preparation ..	43	8	7	8	3
Manuring ..	20	25	15	5	5
Planting and Supplying	3	8	2	—	—
After-Cultivation (including staking)	140	125	27	—	—
Harvesting and Storage	55	15	15	2	5
Total ..	261	181	66	15	13

Cost: Manual Labour	..	$215
Animal Labour	..	18
"Seed"	..	34
Manures	..	44
Overhead Expenses—	..	* 22
Total	..	$333

Labour used in Nigeria.

Labour (in man days per acre) entailed in yam production on Moor Plantation, Ibadan, Nigeria, (17, 18, 19, 21 and 27). All work done by manual labour; crop grown on 6 foot ridges.

	Preparation.	Establishing.	After-cultivation.	Harvesting	Store-work	Total.
1924	42	11	139	34	3	229
1925	30	28	88	27	3	176
1926	44	134	39	37	3	257
1927	23	42	39	26	5	135
1928	26	38	25	17	5	111
Average	33	51	66	28	4	182

The foregoing figures should suffice to give an indication of the labour requirements of the crop. A number of examples of local production costs are quoted by Williams (Yams at St. Clair Experiment Station) in the *Bulletin of the Department of Agriculture, Trinidad and Tobago*, Vol. XVII.

Uses.

The yam provides a cheap and very widespread source of carbohydrate food. Among Europeans in the tropics, it furnishes a substitute for the

* Includes cost of upkeep of roads, hedges, &c., and foreman's wages but not rent or depreciation of implements.

English potato with which some of the varieties compare not unfavourably. Among natives it is used in large quantities; in many parts of Africa it is a staple food; in Porto Rico (3) it ranks second to the sweet potato; in the Philippines (1) it is used mainly by the hill people as a substitute for rice, and in India (4) the yam furnishes a great part of the diet of the lower classes. There, in times of scarcity, even the poisonous *D. daemona* is sometimes used. This is made fit for eating by boiling and soaking in running water, the process being repeated two or three times. In the island of Guam (5) it is deemed a very important starchy food and during famine the wild spiny yam is collected from the forests.

D. fasciculata is grown extensively near Calcutta (4) and used not only for food but also manufactured into starch.

The Purple yam (*D. alata*) is sometimes used for colouring and flavouring ice-creams, and other varieties having a high starch content have been used for alcohol production (3).

Preparations for Use as Food.

For use as food, the yam may be cooked in a variety of ways (3), boiling or baking either whole or in slices. Flavouring such as sugar or coconut may be added or the dried tuber may be pounded into a meal and baked in the form of bread. A favourite method of cooking among natives of parts of West Africa consists of frying slices of the tuber in palm-oil.

Composition.

The table below shows the composition of mature yam tubers in comparison with that of some other starch-bearing roots (6).

	Water.	Crude Protein.	Fat.	Ash.	Carbohydrate.	
					Starch, Sugar, &c.	Crude Fibre.
	%	%	%	%	%	%
Yams	72.9	6.66	.74	3.33	86.00	2.22
Cassava	66.0	3.03	.59	2.06	88.82	5.29
Taro	70.9	6.18	.68	4.12	79.73	2.75
English Potato	78.3	10.12	.46	4.60	83.00	1.74
Sweet Potato	69.0	5.80	2.25	3.55	84.22	4.18

D. fasciculata (3) is rather richer in sugar than other types.

During growth (3) water and protein content decreases as age increases. After passing maturity the proportion of starch decreases; this also occurs when young shoots begin to grow during storage. *D. fasciculata* and *D. daemona* show the greatest decrease in starch content after passing maturity, and these are also the first to produce new shoots. The greatest change during storage is due to loss of water by evaporation and there is a smaller chemical change consisting of the transformation of starch into sugar. These variations are shown below:—

	Water.	*Starch.*
	%	%
Two months before maturity	75.5	73
At maturity	73	79
Two months after maturity	70	67

Good cooking qualities are usually bound up with high starch content which produces a mealy tuber when cooked, varieties rich in protein and poor in starch become wet and soggy. This also applies to immature tubers.

Rough, corky skin often denotes maturity and good cooking qualities, and a smooth skin the reverse, but obviously the variety must be considered in conjunction with this. Yams stored well for a long period taste sweeter than newly harvested roots.

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REFRIGERATING EQUIPMENT.

We learn from Messrs. J & E. Hall, Ltd. that the vessel *Korsvik* belonging to the A/S Kveitefiske of Oslo, Norway, which has just set out for the Greenland halibut fishing grounds, has been fitted out with all the necessary equipment for "quick freezing" by this Company. The plant of the *Korsvik* which is to act as parent ship to a fleet of motor dorys, includes all necessary appliances for "quick freezing" the freshly caught halibut by the "brine immersion" process and subsequently glazing the fish, after which it will be stored on board at a freezing temperature until the vessel's return to port. Two of Messrs. J. & E. Hall's vertical steam driven CO_2 refrigerating machines are installed on this vessel, one of which maintains a temperature which may be as low as O°F. in the insulating spaces, while the other machine which is entirely independent, deals with the "quick freezing" duty. A daily output of 10 tons of fish can be frozen, while the storage space is arranged to hold about 500 tons.

TOMATO EXPERIMENTS.

Preliminary Suggestions for Experiments in Tomato Cultivation in the West Indies.

By D. D. Paterson, B.Sc.

[*The following is a Report prepared for the Field Experiments Sub-Committee appointed by the West Indian Conference of Agricultural Officers. It has been circulated to all the members of the Committee to whom the writer is indebted for many helpful suggestions.*]

Introduction.

There exists to-day a considerable amount of information on the cultivation of the tomato crop in the West Indies, but this is scattered and somewhat inaccessible and is frequently based on very meagre data. In consequence, it is often contradictory and even misleading. This report has been drawn up with the object of showing the quickest way of obtaining some definite answers to questions of variety, systems of cultivation, manures, &c., most suited to tomato growing in these Islands. It has been strictly limited to the period from the sowing of the seed to the harvesting of the crop. Much has already been done to ascertain the best markets, the selling value of the crop and the profit or loss likely to accrue. Improvement in these directions will largely depend on the proper carrying out of the recommendations given by the Departments of Agriculture.

The tomato crop in the West Indies will be grown primarily for sale to the winter Canadian Markets, *i.e.*, for sale in Canada between the months of December and June. This coincides with the ripening period in the Islands, the seed being sown generally in August and the crop harvested from December to March. In some of the wetter islands the crop might be sown later so as to catch the highest price market in Canada—namely April and May. Competition from the southern American states, Mexico, and some of the other Islands is fairly keen, so that it is essential that the crop should be grown under the best conditions and exported in such a way that it will at least compare favourably with the produce from other regions. The West Indies, although more distant from the final market than many of their competitors, have a big advantage in the preferential tariff allowed on their produce imported into Canada. In addition, Canadian buyers are keen to deal in Empire Products. This desire has been stimulated by recent propaganda on the part of various Governments, the Empire Marketing Board, and other similar authorities. The market for tomatoes, though large, is not unlimited. In consideration of these initial advantages, there is no obvious reason why the West Indies should not practically monopolise it. The first step towards this is to map out a correct procedure from the initial sowing onwards. The proposed experiments have been purposely made fairly simple, and they should offer no difficulty to the different Agricultural Officers who will carry them out.

They are also comparatively simple to analyse statistically, but advice can always be obtained on this question. They are intended to supply in the near future some definite data on the main principles of growth. Later on, a further series could be drawn up to go into the various questions in greater detail.

Standards.

Where so many different methods of cultivation exist, it is essential to recommend, as a starting point, a basic system which will be, within reason, common to all the experiments as a control. Each experiment will then take the form of one or more variations from this standard system. Apart from these variations, the experiments will be treated similarly as regards cultivation. The standard chosen in this report is the usual amount of cultural and other operations considered to be consistent with good farming practice and likely to produce a normal good yield of fruit. Unless otherwise stated, all experiments laid down under this scheme should be treated as follows :—

SEED.

This should be sown in carefully prepared nursery boxes or beds; the variety used should be "Bonnie Best" which is the one most commonly cultivated today. The date of sowing should be the commonly accepted optimum for the area. The seed may be broadcast or sown thickly in drills two inches apart, at the rate of 500-1000 seeds per square foot.

TRANSPLANTING.

In about a fortnight, seedlings should be transplanted to a specially prepared nursery bed, and dibbled in about six inches apart.

PLANTING.

Six to eight weeks after sowing, the transplants should be moved to the field, and put in on ridges not less than one foot high. The ridges ought to be made four feet apart and the plants set on the ridges at two-foot intervals. Supplying where necessary, should be resorted to once only, about ten days later. Where the stand all over is good—say over 90 per cent. successes—this operation may be omitted. Needless to say, in any experiment, where one plot is supplied all the other plots must be similarly treated. Cultural operations by hand or implement should be just sufficient to keep the weeds under control and form a fair earth mulch. Immediately after the final cultivation, the most easily procurable form of brushwood should be spread on the ground in a way that will permit of the vines trailing over it and keep the fruit free from contamination from the soil. As far as possible the ridges should be made to run in the direction of the prevailing wind—generally east to west—and a wind-break such as Sugar-Cane or *Gliricidea* grown to the east of the area. Where insect or other pests make their appearance, all reasonable measures against them should be employed, all the plots in any one experiment being so treated.

FERTILISERS.

Farm Yard Manure at the rate of ten tons per acre should be used. If thoroughly well rotted it may be applied at the time of ploughing the land previous to ridging up. If not well rotted it should be ploughed in some three months before transplanting the crop. Where Farm Yard Manure is *not available*, artificials at the rate of 500 lb. per acre should be added at the time of ridging up. The artificials used should be Nitrate of Soda, Superphosphate and Muriate of Potash in the proportion 1: 2: 1.

HARVESTING.

The crop should be harvested for the export market and graded according to the usual standards, 1st, 2nd, 3rd, and trash.

LAY-OUT.

The lay-out in all cases will be of the controlled randomised type *i.e.*, so many similar blocks, each block being subdivided to equal-sized plots. The number of plots in any one block must be equal to the number of different treatments to be tested and the arrangement of the treatments among the plots of any block must be at random. A random arrangement is most easily obtained by writing the names of the different treatments on seperate slips of paper and drawing these one by one, by chance, from a box. The order in which they are taken out will be the order the treatments appear in the block starting at any given corner. This process has to be repeated for each block. The size of the plot should be between one-thirtieth and one-sixtieth of an acre. The shape of the plot is immaterial but it should be made to take an exact number of ridges of the requisite size. For the proposed experiments, five replications of any treatment, *i.e.*, five blocks, will suffice.

The statistical data will be worked out on the total yield of fruit suitable for the export market and this produce from each plot must be weighed separately. Final conclusions drawn from this analysis should take into account the probable *net* value of the produce, as determined by expert opinion on the quality, carrying ability, &c., of the fruit. The *saleable* value of the trash ought to be included in this estimation of the *net* value, and also the comparative cost of production of the different treatments.

Experiments.

These have been divided into three main groups, in all of which early information is urgently required.

(*a*) Varieties.
(*b*) Cultural Treatment.
(*c*) Manurial Treatment.

(*a*) *Varieties.*—Automatically, thanks to the season in which the tomatoes are grown in these regions, the problem of producing a quick ripening variety for the early market does not exist. The selection of varieties will therefore be for heavy yield, good and regular quality, carrying ability, hardiness, and market demand.

Previous experience has shown that the following varieties all show promise, though their relative merits are not definitely known.

Globe Group
(1) Marglobe.
(2) Livingstone Globe.

Bonnie Best Group
(1) Bonnie Best.
(2) John Baer.

These four varieties are therefore included in this preliminary varietal experiment. It is essential in order to compare results from the different islands that the seed should be obtained from the same source. This could probably be arranged with the co-operation of the Commissioner of Agriculture. As varieties respond very differently to different spacings it has been thought advisable to include three different spacings in the experiment. This does not detract from, but rather adds to, the probability of obtaining definite information as regards the varieties under test. Fairly wide ridges, combined with closer planting in the ridge, have been retained throughout, as this makes for ease in cultivation. The spacings included are:—

(*x*) 4′ ridges with 3′ planting
(*y*) 4′ ,, ,, 2′ ,,
(*z*) 3′ ,, ,, 2′ ,,

The treatments will therefore be as follows:

(1) Marglobe on 4′ ridges with 3′ between plants.
(2) Marglobe on 4′ ridges with 2′ between plants.
(3) Marglobe on 3′ ridges with 2′ between plants.
(4) Livingstone Globe on 4′ ridges with 3′ between plants.
(5) Livingstone Globe on 4′ ridges with 2′ between plants.
(6) Livingstone Globe on 3′ ridges with 2′ between plants.
(7) Bonnie Best on 4′ ridges with 3′ between plants.
(8) Bonnie Best on 4′ ridges with 2′ between plants.
(9) Bonnie Best on 3′ ridges with 2′ between plants.
(10) John Baer on 4′ ridges with 3′ between plants.
(11) John Baer on 4′ ridges with 2′ between plants.
(12) John Baer on 3′ ridges with 2′ between plants.

Thus, the experiment will consist of five blocks of twelve plots each, one plot of each treatment occurring once in each block. This experiment should show the best general variety, the best general spacing, and the best spacing for the the best variety.

In addition, observation rows or plots of these varieties and others likely to be suitable, should be planted. Promising types should be selected, and, after two or three years of careful observation, the best of them might be included in further varietal trials. In consideration of the importance of fungoid diseases, it would be advisable to include in these demonstration groups, strains that are resistant to Fusarium Wilt, as are some of the Stone group of tomatoes.

(*b*) *Cultural Treatment.*—The question of spacing has been tested in the varietal experiment. Two other fundamental systems of cultivation seem worthy of immediate trial, namely staking and mulching. In order to make the test of these more general in application, two varieties have been included representative of the two groups of tomatoes. The treatments therefore are:—

(1) Marglobe staked but not mulched.
(2) Marglobe mulched but not staked.
(3) Marglobe staked and mulched.
(4) Marglobe neither staked nor mulched.
(5) Bonnie Best staked but not mulched.
(6) Bonnie Best mulched but not staked.
(7) Bonnie Best staked and mulched.
(8) Bonnie Best neither staked nor mulched.

The stakes used may be of any suitable material sufficiently strong to form a sure support to the plant. They should be firmly fixed in the ground and the projecting portion should not be less than four feet high. The plants should be fastened to the stakes with raffia or similar material. In addition, all staked plants must be pruned or suckered in the customary manner so as to leave a single stem to bear the produce. The mulch should consist of cane trash or other suitable and available organic matter at the rate of six tons per acre, applied after a thorough cultivation as soon as the plants have become firmly established.

As the main questions of staking and mulching will be based on the means of 20 plots, definite results should accrue from this lay-out.

(*c*) *Fertilisers.*—A reasonable amount of Farm Yard Manure or of a complete artificial fertiliser has been stipulated in the standard treatment as essential to good crop production. The following manurial treatments will be *in addition* to this. Experiments carried out in the United States of America and elsewhere are decidedly contradictory as regards the particular fertilisers most beneficial to the tomato crop. Many show that the tomato responds most frequently to Phosphate. Some advocate a high proportion of Nitrogen, others of Potash; Nitrate is said to be better than Sulphate of Ammonia and so on: nothing very definite. Obviously the results largely depend on the soil where the experiment was carried out. After due consideration of the available information, the following series has been selected:—

Additional Nitrate of Soda at the rate of 200 lb. per acre.
Additional Muriate of Potash at the rate of 200 lb. per acre.
Additional Superphosphate at the rate of 200 lb. and 400 lb. per acre.

The manures used should be a commonly accepted standard grade and to ensure quality should be obtained from one source only. The heaviest total dressing of manure will be about as much as is economically feasible or likely to be employed by the cultivator. Treatments will be as follows:—

(1) No additional manure.
(2) Potash.
(3) Single dressing of superphosphate.
(4) Double dressing of superphosphate.

(5) Potash and single superphosphate.
(6) Potash and double superphosphate.
(7) Nitrate.
(8) Nitrate and potash.
(9) Nitrate and single superphosphate.
(10) Nitrate and double superphosphate.
(11) Nitrate and potash and single superphosphate.
(12) Nitrate and potash and double superphosphate.

These twelve treatments repeated over five blocks should show definitely the general effects of the three manures, and, in addition, may supply some information as regards quantity required. A great deal will depend on the particular type of soil on which the experiment is laid out. A general description of the soil is therefore essential if correct conclusions are to be formulated. Soil analysis would be advantageous, but on account of paucity of staff, will be impractical in most localities.

General Comments.

The three experiments proposed will not, in any way, supply all the information required about the cultivation of the tomato. They should, however, afford sufficient data to permit the issue of general but fairly accurate recommendations for correct cultural treatment. To be really effective, the experiments should be laid out in as many of the interested islands as possible, and repeated for at least two years in succession. The sites chosen for the experiments should be typical of the tomato growing areas of the island, and selected for uniformity of soil and fertility. Positive results can only be expected if the recommendations given are followed exactly. The success or otherwise of these experiments will therefore depend on the actual superviser on the spot, and the care with which the instructions are followed. A specimen plan of a suitable lay-out for the experiment on cultural treatment is given below. The other two experiments should be laid out in a similar manner except that each block will be made up of twelve instead of eight plots. The arrangement of the plots within the blocks must be a chance one and is best determined by the officer responsible in each case.

Specimen lay-out for Experiment II.

The numbers refer to the different treatments as quoted in the text in Paragraph IVb.

Block I.

2	7	8	6
5	4	1	3

Block II.

8	7	4	1
5	3	6	2

Block III.

3	5	6	8
7	2	4	1

Block IV.

1	6	5	8
2	4	3	7

Block V.

4	8	3	5
2	7	8	1

The appended suggestions are well worth a trial when a more comprehensive scheme is considered advisable.

(1) New varieties selected from the observation plots.
(2) Transplanted as compared with non-transplanted seedlings.
(3) Dates of sowing particularly with regard to catching the highest market.
(4) The correct ratio between ridge width and plant spacing for the best variety.
(5) The interaction between spacing and staking.
(6) Time of application of manures.
(7) Additional dressings of Farm Yard Manure alone and in combination with artificials.
(8) Correct ratio of the three artificials.
(9) Nitrate as compared with ammonium sulphate.

Resume of Experiments.

Each experiment will consist of five blocks, every block being subdivided into as many plots as there are treatments. Each treatment will appear once only in each block. The plots in any particular experiment should be made exactly the same in size and shape; these last two factors will naturally depend on the site selected, but the site must be chosen to permit of plots between one-thirtieth and one-sixtieth of an acre in extent. The arrangement of the different treatments among the plots of any one block must be a random one determined by the Agricultural Officer supervising the experiment.

At harvest, the weight per plot to the nearest lb. of 1st, 2nd and 3rd grade fruit, *suitable for export* should be recorded, and also the weight of the remainder of the fruit that can be sold locally. The statistical data will be calculated on the *total weight of produce suitable for export*. In addition, careful records should be kept of the general cultural programme as, for example, date of sowing, number and kind of cultural operations, percentage failures in the transplants, prevalence of insect and fungoid pests, &c.

Experiment I.

A trial of four varieties at three different spacings.

Total No. of plots .. 60
No. of plots per block .. 12
No. of treatments .. 12 (as enumerated in Para. IVa).

Experiment II.

A test of the effect of staking and mulching on two varieties.

Total No. of plots .. 40
No. of plots per block .. 8
No. of treatments .. 8 (as enumerated in Para. IVb).

Experiment III.

A test of the effect of Nitrate, Phosphate and Potash, alone and in combination, when applied in the form of an artificial fertiliser.

Total No. of plots .. 60
No. of plots per block .. 12
No. of treatments .. 12 (as enumerated in Para. IVc).

EMPIRE COTTON GROWING.

Production and Consumption.

By John A. Todd, M.A., B.L.,

The annual meetings of the British Cotton Growing Association and the Empire Cotton Growing Corporation, both held during the month of May, provide an appropriate occasion for a review of the progress of Empire cotton and a consideration of the place which it has now made for itself in the world's cotton supplies and consumption. The present abnormal conditions of cotton supply and demand make such a survey a very disturbing business.

When the B.C.G.A., was founded in 1902 the cotton world was beginning to realize the danger of a shortage of supplies and the fact that the world's supplies were too largely dependent on one source—the United States. The world's consumption was increasing, not faster than the supplies because that of course is impossible, but as fast as the increasing supplies would allow; and there was reason to believe that actual shortage leading to an undesirable rise of prices was within sight. At that time 6*d*. a lb. was looked upon as a high price for cotton, which had actually been below 3*d*. in 1894 and 1898, and the danger of scarcity was emphasised by Sully's Corner which in January, 1904, sent prices up to nearly 9*d*. a lb.—the highest price known since the Civil War. Sully's Corner, however, was soon broken, and from 1904 to 1914 prices were on the whole rising as the result of the pressure of potential demand on supplies which were not increasing fast enough to meet it.

At the same time it was felt that cotton provided an ideal means of developing the Empire especially our new territories in Africa. In those days India was practically the only country in the Empire which produced almost any cotton at all, and her crop was only about three million bales. The efforts of the B.C.G.A., were at first directed mainly to West Africa, with which most of the promoters of the Association were directly concerned, and then were quickly extended to every part of Africa, including the Sudan, India and the West Indies. Experiments were also initiated in many of the smaller outlying parts of the Empire such as Fiji, and, nearer home, Malta and Cyprus. To cut a long story short, by 1914 the Indian crop had been increased to five million bales, while the total yield from all the other new fields had risen to nearly 100,000 bales of 400 lb. in which unit the Empire crops have always been stated.

During the War, of course, all the world's cotton crops were severely handicapped, but with consumption also restricted supply and demand balanced fairly well. On the other hand prices rose enormously as part of the general rise of world prices. When the War was over the expectation that both supplies and consumption would quickly recover was not realised and in 1919 although the world's crops were still small, the demand for cotton, or rather for cotton goods, suddenly shot up at a rate far in excess of the world's immediate capacity to produce them. As this was accompanied by a new period of inflation prices rose to levels which, especially in the case of Egyptian, were far in excess of anything ever recorded even during the Civil War. This boom, however, was very short-lived. In 1920 the American crop made a fair recovery though the Indian crop was a serious failure, with the result that the world's total was slightly less than in 1919. In the meantime deflation had set in and prices collapsed below pre-war levels and as the result of the strangulation of the world's demand the Carryover of American cotton at the end of that season was record breaking. The recovery, was almost as sudden owing to the dramatic failure of the American crop in 1921 as the result of unprecedented weevil damage, which was repeated in the next two seasons, and again the world was faced with a scarcity of cotton (especially American this time) and high prices. Nevertheless the American crop repeated its capacity for dramatic surprises; in 1924, 1925 and 1926 the weevil seemed somehow to disappear and the American crop mounted steadily up till in 1926 it almost touched 18 million bales excluding linters, as against the pre-war record of 16 millions in 1914. The result was again an over-supply in that season, accentuated by the fact that the Indian crop had been establishing record figures (6,215,000 bales in 1925-26) and prices again fell below pre-war. Once again, however, the American crop executed a *volte face* and in 1927 it was only 13 million bales, with the result that prices made a fair recovery. Since then the American crop has fluctuated round about 14 to 15 million bales, and as the other world's supplies (except India) have been on the whole rising, especially the Russian crop the world's total has held fairly steady at about 28 million bales against 30 millions in 1926 and 28 millions in 1914. Thus the total supplies are just about back to pre-war level.

During the last 18 months a complete change has come over the position, and this time again it is from the side of demand, as in 1920. The Wall Street crash in October, 1929, proved to be merely the beginning of a great world depression which has carried the prices of many staple commodities, especially agricultural products, far below pre-war levels, and although cotton has not yet reached the low level of 1894-98 it is well below the general average. Thus with a supply which is by no means burdensome, and with consumption cut down below pre-war levels the world's Carryover is now mounting to very near record figures, and instead of there being any question of scarcity of cotton the world's supplies are definitely super-abundant on the present scale of consumption.

This generalisation, however, does not quite tell the whole story. The position is that the stocks of American and Egyptian cotton are enormous, but others are probably no more than normal, and this has been largely brought about

by a very marked transfer of consumption from American and Egyptian to other growths, with the result that while American and Egyptian have added largely to their Carryovers during the past season, the position is probably the reverse with the other varieties, though there are no complete statistics available to check that statement.

So much for the general world position of cotton as regards both supply and demand. The next question is to see how Empire cotton in particular has moved during the same period.

As to supplies the position is summarised in Table I, which shows separately the production in India and in the new Empire fields as a percentage of the world's total. This distinction

TABLE I.

World's Cotton Crops—Distinguishing Empire.

(000's Omitted.)

Season.	World's Total.	British Empire.			
		India.		New Fields.	
	500 lb. bales.	400 lb. bales.	Per cent. on Total.	500 lb bales.	Per cent. on Total.
1914-15	28,212	5,209	18.5	75	0.27
1915-16	21,096	3,738	17.8	54	0.26
1916-17	21,883	4,489	20.5	66	0.30
1917-18	21,295	4,000	18.8	51	0.24
1918-19	22,243	3,972	17.9	68	0.30
1919-20	22,913	5,796	25.3	86	0.38
1920-21	21,907	3,600	16.4	134	0.61
1921-22	16,601	4,485	27.0	92	0.55
1922-23	20,367	5,073	24.9	134	0.66
1923-24	21,020	5,161	24.6	203	0.97
1924-25	26,544	6,088	22.9	286	1.08
1925-26	29,803	6,215	20.9	342	1.15
1926-27	30,366	5,024	16.5	294	0.97
1927-28	25,846	5,963	23.1	272	1.05
1928-29	28,180	5,782	20.5	374	1.33
1929-30	28,200	5,125	18.2	333	1.18
1930-31	**27,272**	**4,820**	**17.7**	**319**	**1.17**

Estimates in thick heavy type.

between India and the new Empire fields is necessary for two reasons. In the first place the quality of the Indian crop is radically different from that of the new fields. The Indian crop is on the whole well below the average of the American crop in staple and value, while nearly all the new fields are well above it, especially of course the Sudan and the West Indies. The statement with regard to the quality of the Indian crop requires qualification, because since about 1914 there has been a very definite improvement in the quality of much of the Indian crop with the result that about one-third of it is now of $\frac{7}{8}$inch staple and above. This brings it practically up to the standard of a large and increasing part of the American crop, which has been steadily deteriorating in staple. The second reason is that the history of the Indian crop as regards quantity since 1914 has been quite different from that of the new fields. The quantity of the Indian crop, as will be seen from the table, has fluctuated very widely during the period. Stated as a percentage of the world's total, these fluctuations are largely due to the accidental fact that in quite a number of these years the Indian crop has moved the opposite way from the American, being large when the American crop was small, *e.g.*, in 1919 and 1927, and small in the years of big American crops, *e.g.*, 1926. Unfortunately for the last five years the Indian crop has fallen very far short of its record in 1925, and as a matter of fact the estimate for 1930 is the smallest since 1921. Here again the statement must be qualified because unfortunatley the Government estimates of the Indian crop are almost always well below the figures of the "Commercial" crop, which is arrived at by a calculation of exports and consumption. This is the excuse for allowing the Indian crop figures in the Table which are in 400 lb. bales, to stand in comparison with the world's total which is in 500 lb. bales, because over a long period of years the difference between the Government estimate and the Comercial crop is not far short of the difference between the two bale weights. The result is, however, that the relative weight of the Indian crop in the world's

total has fluctuated very materially since 1914, and is now back to just about the same percentage as it was then.

With regard to the new Empire fields the position is entirely different. They have on the whole risen steadily, both in actual figures and in percentage, throughout almost the whole period, though here again, there has been a check in the last two years; but while this steady progress is satisfactory we have to face the fact that the total of these new fields is still well below half a million bales and is little more than one per cent. of the world's total.

Turning to the details of the new Empire fields as given in Table II, there are a good many interesting points to be noted. The largest single crop is in Uganda which in 1928 was a little over 200,000 bales (the figures throughout this table are in 400 lb. bales) and may almost reach the same figure again this year. Tanganyika has also been going ahead rapidly in recent years, its record being 32,594 bales in 1928. Progress in Nyasaland is very slow though it nearly reached 10,000 bales in 1929, and Kenya has only twice exceeded 2,000 bales. In all these areas the major difficulty has been transport, the distance from the sea involving a long haul by railways, the construction of which has taken much time and money. Rhodesia, both North and South, have had great difficulties to contend with, and their total crop now hardly reaches 2,000 bales. South Africa made its record (20,381 bales) in 1925 but there the chief difficulty seems to have been to breed suitable varieties of cotton, especially types resistent to the local pest, jassid. The work done there, however, in the production of immune varieties is likely to yield valuable results in many other parts of Africa.

In the Sudan the great hopes which had been entertained of steady progress have also unfortunately suffered a severe check since 1928 owing to the combination of two diseases, namely black arm, which is apparently due to climatic conditions, and a new virus disease which is carried by an insect pest, the White Fly. The combination of these two has proved very serious

TABLE II.

Empire Cotton Crops (New Fields) 1914-1930.

(400 LB. BALES.)

Season.	West Africa.	East Africa.	Rhodesia and S. Africa.	Sudan.	West Indies.	Australia Iraq and Sundries.	Malta and Cyprus.	Total.	U. K. Consumption Federation Statistics.
1914-15	14,516	42,943	759	23,765	6,031	249	5,826	94,089	..
1915-16	7,187	33,915	798	16,219	5,616	608	4,014	68,357	..
1916-17	19,491	31,981	681	22,971	3,748	161	2,867	81,900	..
1917-18	12,604	33,722	534	11,263	3,398	78	2,374	63,973	..
1918-19	17,552	43,296	1,967	15,997	4,462	31	1,315	84,620	..
1919-20	16,348	53,950	2,772	23,160	6,415	208	3,668	106,521	..
1920-21	30,061	93,543	3,023	30,519	5,873	1,000	2,953	166,972	..
1921-22	15,145	61,456	2,828	24,074	4,888	3,200	3,129	114,720	..
1922-23	16,826	100,457	6,625	28,306	4,246	9,693	1,698	167,851	71,446
1923-24	25,787	148,564	10,880	47,652	5,292	13,382	2,351	253,908	105,552
1924-25	40,269	224,799	22,222	44,912	4,305	17,166	3,970	357,643	107,904
1925-26	49,127	209,605	27,690	121,131	4,189	10,677	4,102	426,521	177,249
1926-27	27,749	160,032	10,913	148,118	5,938	10,422	5,121	368,293	207,934
1927-28	21,194	160,163	11,120	126,115	6,080	12,630	2,452	339,754	219,577
1928-29	32,422	245,101	10,054	161,536	4,088	11,990	2,687	467,878	148,890
1929-30	44,125	168,603	17,694	158,359	5,295	17,973	3,989	416,038	179,153
1930-31	**15,000**	**221,313**	**17,000**	**120,593**	**5,677**	**14,200**	**5,071**	398,854	74,737 (1st Half)

Estimates in thick heavy type.

during the past season, and while energetic measures are being taken to deal with the new pest it is too soon yet to say when these will be successful.

In West Africa the position is entirely different from all our other African possessions. Although Cotton is indigenous in Nigeria the native varieties are very short stapled while the native methods of handling the crop were of course extemely primitive and the average yield was very small. The problem there has been first to find an improved variety which would give a heavier yield and longer staple, and considerable success has been achieved in this direction especially in Northern Nigeria. With this and improved methods of cultivation, ginning, baling, &c., done entirely under the auspices of the B.C.G.A., the crop has shown a fairly satisfactory increase, the record in 1925 being nearly 50,000 bales. It has, however, been a hard struggle to maintain this rate of progress. Last year for example the crop was a failure owing to locusts, and there is no getting away from the fact that the average yield for the country as a whole is still very low. In other West African possessions such as Sierra Leone and the Gold Coast, cotton has had to face very serious competition from other crops and has not made any great progress.

The West Indies has been one of the most marked successes of the B.C.G.A., and the development of the Sea Island crop there has of course gained increased importance through the complete failure of the American Sea Island crop about 1917-18. In the West Indies cotton has to face the economic competition of other crops especially sugar, and the history of the crop has practically been the history of the relative economic advantages of sugar and cotton. In recent years much trouble has also been experienced with pink bollworm although methods have now been worked out which seem to reduce very substantially the damage done by this pest. The last three years have shown a substantial recovery of the crop though the total is still well below the record of 1919.

Of the other newer and on the whole smaller fields the two most interesting are Australia and Iraq. Neither of these has fulfilled the high expectations which were entertained in the early post-war years when their development began. In Australia the labour difficulty is probably the chief handicap, for if the experience of the rest of the world goes for anything, cotton is not a white man's crop, and Australia is determined to remain a white man's country. In Iraq the conditions are entirely different, the crop being grown wholly under irrigation and the main difficulties have been political and financial. The hope that Iraq would become a second Egypt has therefore been pretty well abandoned.

Of the smaller Empire crops Fiji, where Sea Island is mostly grown, is perhaps the most interesting but the quantity is still small, and finally it may be a surprise to many people in England to know that so near home as Malta and Cyprus a crop of about 5,000 bales (almost as much as the whole of the West Indian crop) has frequently been produced.

Turning now to consumption it is unfortunately very difficult to get statistics of the consumption of Empire cottons. The International Federation's statistics only distinguish between American, Indian, Egyptian and "Sundries" and of the Sundries they only give details for certain countries and not always for all of these. Again, even where details are given they do not distinguish between Empire and other sources in the same area, *e.g.*, West Africa and East Africa. Thus it is impossible to say whether the "West African" cotton consumed in Germany comes from British, French or other countries' colonies in West Africa. On the other hand, it may be assumed that West African or Sudan cotton consumed in France comes from their own colonies, not the British, and that East African cotton consumed in Portugal or Italy comes from their respective colonies in these areas. Again "West Indian" in the Federation figures, judging by the total figures, obviously includes a great deal more than the product of the British West Indies. In Table III, all the details that can be extracted from the Federation figures have been put together and the result is very interesting. Briefly it shows that while the world's consumption of all kinds of cotton since 1925-26 has not varied very much until the first half of this season, the consumption of American and Egyptian has fallen off very heavily, while that of Indian and of other Empire cottons has increased, and that of other Outside Growths has been fairly steady. This is satisfactory as far as it goes, but it is not so satisfactory that Lancashire's consumption of Empire cottons from the new fields, of which the statistics should be fairly complete and are added to Table II, forms such a small proportion of the total production, being in fact, seldom as much as half*. Lancashire of course consumes very little Indian cotton, though the total has increased very markedly in recent years. That cannot be helped, but because Indian cotton on the whole is not good enough for Lancashire's purposes, practically all the cotton grown in the new fields is of kinds that Lancashire can use. The fact is that all through the early days when Empire cottons were new it was very hard to persuade a Lancashire spinner to use them or at least to pay a fair price for them. The quantity was small and the supply irregular, and as long as the spinners could get plenty of good American and Egyptian cotton it was easier to stick to these well-known varieties. When the supply of the better grades of American began to fail, and the price of Egyptian went very high, spinners became much more willing to experiment with Empire cottons and the results have been on the whole very satisfactory. They did the same

*This again must be accepted with some reservation, *e.g.*, the Liverpool Cotton Association gives substantially larger figures each season, but even these do not materially alter the position.

TABLE III.

World's Cotton Consumption—Distinguishing Empire.

(Running Bales 000's.)

Season.	World's Total.	American.	Per cent. of Total.	Egyptian.	Empire.			Per cent. of World's Total.	Other Outside Growth.
					Indian.	Others.	Total.		
1925-26	24,686	13,736	55.6	920	5,572	220	5,792	23.5	4,238
1926-27	26,139	15,777	60.4	994	5,196	278	5,474	20.9	3,894
1927-28	25,541	15,407	60.3	957	4,523	280	4,803	18.8	4,374
1928-29	25,872	15,066	58.2	989	5,178	229	5,407	20.9	4,410
1929-30	25,201	13,015	51.6	937	6,087	345	6,432	25.5	4,817
1930-31 .. .. (1st Half)	11,164	5,278	47.3	394	3,013	162	3,175	28.4	2,317

also with every other kind of cotton, *e.g.*, Peruvian, Brazilian, Argentine and now Russian, of which of course the supplies were very much larger, and they have always used more of these than of the cotton from the new Empire fields.

There is then no escaping the conclusion that Empire cottons are still very far from taking the place of other sources of supply, either in the world as a whole or in Lancashire in particular, and there is no immediate prospect of their doing so. Lancashire cannot use much Indian cotton, and even if she used the whole production of the new Empire fields, she would still require large supplies from other countries. We are still, therefore, a very long way from the ideal that the British Empire should be self-contained in regard to its cotton supplies.

It would be a great mistake, however, to draw from all this the conclusion that Empire cotton growing is not worth bothering about, that it has failed to make any material contribution in quantity to the world's total supplies, and that these are now so ample that there is no need to worry about Empire cotton. It is true that the world's supplies of cotton as a whole are at present ample, if not almost burdensome, but in the first place this condition is only temporary and is due to the strangulation of the world's demand by an abnormal period of depression, which will certainly pass. The world's demand for cotton goods will then revive, though it is unfortunately doubtful whether England's share in supplying that demand will ever recover to pre-war figures. It must not be forgotten that the world's production of cotton today is no more than it was before the war, and everyone was convinced then that that was not enough because the world's potential consumption was increasing at the rate of probably half a million bales per annum and would continue to do so. That is almost certainly as true as ever it was, and when consumption recovers the shortage of supplies may well be greater than ever, because the American crop has fallen off so badly both in quantity and quality. It must be realised that during the last two or three seasons an acute scarcity of good American cotton has only been avoided by the appearance of entirely fortuitous supplies from other sources *e.g.*, a surplus of Brazilian cotton in 1929-30, and the extraordinary increase of the Russian crop in the last two seasons. The latter especially cannot be relied upon permanently to fill the gap created by the failure of the old supply of good Texas cotton. Russia at present is forced as part of the five-year plan, to export all the cotton she can, but some day she will want to consume at home a much larger proportion of her own production.

Again, the quality of the Empire supplies is very largely special. The West Indies crop for example, is now practically the only supply of Sea Island cotton in the world. The Sudan crop has served an important purpose in supplementing the supplies of Egyptian Sakel. East African cotton has proved a valuable substitute for Egyptian Uppers and Peruvian, and finally, the improvement of the Indian crop has led to important developments and a relatively large increase of consumption not only in England but in many other countries.

Thus, the Empire crops while not in themselves very large in quantity, have played a very important part by filling up gaps here and there in the world's supplies, and they have more than justified all the labour and expenditure that has been devoted to them. It would be the greatest possible mistake, even under the present adverse conditions, to allow the results of that thirty years' work to lapse. The time will come again when we shall want Empire cotton as badly as ever and the organisations of the British Cotton Growing Association and the Empire Cotton Growing Corporation, which have been built up through all these years, must be maintained in their full efficiency.

ENTOMOLOGICAL NOTES.

Compiled by the College Department of Entomology.

Insect Pests of Cacao in Santo Domingo.

The insects of economic importance on cacao in Santo Domingo are a termite, *Nasutitermes morio*, Latr.; *Pseudococcus citri*, Risso, against which the introduction of the predacious Coccinellids, *Cryptolaemus montrouzieri*, Muls. and *Scymnus binaevatus*, Muls., and the parasite, *Tanaomastix abnormis*, Gir., is suggested; and *Selenothrips rubrocinctus*, Giard, which is the most injurious. During the dry season this thrips increases to such an extent as to cover the lower surfaces of the leaves, but it is washed away by rain. It is estimated that 75 per cent. of the cacao plantations are injured, owing to the absence of suitable shade. This can be obtained rapidly by planting bananas, but *Erythrina micropteryx* should be grown for permanent shade until a more satisfactory tree with a less extensive root-system can be found. The addition of nicotine to the Bordeaux mixture used as a fungicide is effective against this thrips.—(*Review of Applied Entomology*, Vol. XIX, Ser. A, Part 3.)

* * *

Biological Control of Mealybug in Kenya.

In view of the seriousness of the loss caused to the coffee crop by *Pseudococcus lilacinus*, it has been decided in addition to retaining the method of banding against the ants that foster it, to make renewed attempts to render the aid of predators more certain and effectual. In order to pursue the study of the more promising predators, it is proposed to erect six specially constructed insectaries, where one or more selected species will be produced on a large scale, potato sprouts infested with the mealybug being used as the food-supply.

In addition to *Cryptolaemus montrouzieri*, Muls., it is hoped to adapt the breeding process to some of the indigenous species, the most numerous and effective of which is *Chilocorus angolensis*, Crotch. The adult and larva of this Coccinellid pupates on the leaves and stems of the coffee tree and is therefore not likely to be trapped by ant-repellant bands, and is large enough to offer considerable resistance to ants. Difficulty has hitherto been experienced in breeding experiments with *C. angolensis*, since the adults devour the mealybugs so quickly that they lay very few eggs in the time available, only small numbers being laid by this species at one oviposition. The eggs hatch in one to two days, the larval stage lasts from three to four weeks, according to the amount of food consumed and the temperature, and the pupal stage 16 to 19 days. The larvae attack each other if the food-supply is exhausted. The female is capable of laying 100 to 250 eggs. Experiments will be conducted to discover an artificial food on which the Coccinellids can be reared and bred. One already tested, consisting of eggs, batter and honey, while keeping them alive, inhibits reproduction.

Another indigenous predator is *Hyperaspis delicatula*, Muls. This Coccinellid is about the same size as *Cryptolaemus* and may therefore be more adaptable to breeding than *Chilocorus*, but as it crawls down the main stem of the coffee tree to pupate in the soil, it is liable to be trapped in adhesive bands. *Scymnus guttulatus*, Sic., is also present throughout the infested areas and may prove valuable for breeding purposes. Although the incidence of internal Hymenopterous parasites of *P. lilacinus* appears to have recently increased, they are still without significance in controlling the mealy-bug in Kenya.—(*The Review of Applied Entomology*, Vol. XVII, Ser. A, Part 12.)

* * *

Termite Damage in Ceylon.

In the 1929 Technical Report of the Department of Agriculture, Ceylon (Entomological Section), termites that are primary pests of plants of economic importance in the Colony are discussed. New food-plant records, among which are some undescribed species, include: *Coptotermes ceylonicus*, Holmgr., on coconut palms; *Calotermes* (*Neotermes*) *greeni*, Desn., on mango; *Artocarpus integrifolia*, dadap, &c.; and *C.* (*Glyptotermes*) *dilatatus*, Bugnion and Popoff, on guava and dadap. *Termes horni*, Wasm., a soil-nesting species that usually attacks dead wood, was found damaging *Canavalia ensiformis* and the unexpanded leaves of an ornamental palm. In investigations on the biology of termites, the winged forms were not produced in captivity, but apterous egg-laying forms of both *C.* (N.) *militaris*, Desn., and *C. dilatatus* were obtained within nine months of the hatching of the larvae. The method of controlling *C. militaris* on tea by introducing Paris green into the infested part of the plant is discussed. Notes are also given on termites injurious to buildings and building materials; pieces of Burma iron-wood (*Xylia dolabriformis*) placed in the nests of a number of subterranean species were not damaged. Preliminary experiments in the control of subterranean termites are described. Petrol, applied with a funnel into holes made in the nest (1½ ounces to each hole), resulted in the destruction of the entire colony. It should be introduced at about six different points, forming a circle with a radius of about 18 inches from the centre of the nest, one application being also made in the centre where the ventilating aperture is generally situated. The holes should immediately be covered with loose soil, well trodden down.—(*Review of Applied Entomology*, Vol. XIX, Ser. A, Part 3.)

MYCOLOGICAL SERIES No. 4.

This Memoir (price 2*s.*) which has recently been published can be obtained on application to the Editor, Imperial College of Tropical Agriculture, Trinidad, B.W.I.:—It is entitled "*Macrophomina Phaseoli* (Maub) Ashby in Trinidad" and is by J. West, B.S.A., A.I.C.T.A., and R. W. Stuckey, M.A., B.S.A., A.I.C.T.A.

RAT CONTROL IN HAWAII.

In an article by C. C. Barnum on "Rat Control in Hawaii" which appears in the *Hawaiian Planters Record* an outline of the work done in Hawaii and elsewhere is given, followed by a report on recent investigations conducted on the island of Kauai. Tests on 453 wild caged rats of various species are reported. Strychnine rat baits were found inefficient and distasteful to rats. Barium carbonate preparations, although highly toxic, were ignored until the rats, deprived of other food, were forced to eat them.

Thallium sulfate-treated wheat bait, of a 1 to 1,000 weight ratio, proved to be highly effective, was eaten by all rats offered such preparations and death ensued within an average of three days in all cases. Tests with field rats proved the effectiveness of this bait and it has since been adopted on those plantations which are now practising rat control in the cane fields. A marked reduction in numbers of rat-eaten canes coming to the mills has been effected within the first year of general use. Improved mill juices have resulted from the use of thallium sulfate-treated wheat baits.

The formula for preparation is detailed as follows:—

Ingredients.	Small Lot, Amounts.	Amounts in Grams or CC's.	Ton Lot, Amounts.	Procedure.
Starch ..	1 tablespoon.	9.0 gms.	2.0 lb.	
Water ..	¾ pint	354.0 cc.	6.8 gls.	Add and boil for 15 minutes.
Baking soda ..	1 ounce	28.35 gms.	5.5 lb.	Stir and boil.
Thick syrup ..	½ pint	118 cc.=175.7 gms.	2.3 gls.	Stir and boil.
Glycerine ..	1 tablespoon.	24 gms.	4.6 lb.	Stir.
Saccharine ..	1/10th ounce	2.83 gms.	8 ozs.	Stir.
Thallium sulfate	(in warm water)	10.328 gms.	2 lb.	First dissolve in hot water. Mix thoroughly after adding to paste.
Whole wheat ..	13 qts. or 22¾ lb.	10,328 gms.	2,000 lb.	Paste is added to small lots in proportionate amounts and thoroughly mixed.

Treated grain to be spread immediately for drying.

Caution.—Do not allow this solution or paste to come in contact with the skin until after drying.

One ten-gram portion of the preparation is a lethal dose for an adult rat and such portions wrapped in paper torpedoes and dipped in melted paraffin makes excellent waterproof packages for field distribution. Precautions must be taken in handling the drug as thallium is very poisonous to man. When in aqueous solution it is readily absorbed through the skin and is especially dangerous when handled continuously. Such contacts often result in lameness, and falling of the hair. After a time the hair is usually replaced with a new growth. For those who are handling this poison in an aqueous solution, the use of rubber gloves is recommended. For those who handle the dry thallium-treated wheat, frequent washing of the hands and as little skin contact with the poison-coated grain as possible, is recommended. Frequent washing of the hands and thorough drying are essential to safety in handling this preparation.

NATIVE HEALTH.

Dr. J. B. Orr, Director of the Rowett Research Institute for Animal Nutrition, and Dr. J. L. Gilks, Director of the Medical and Sanitary Service, Kenya, have recently completed three years' research into the diets and diseases of two African tribes, the Masai and Akikuyu. The report of their work has been published by the Medical Research Council. The authors found that the Akikuyu diet was too rich in carbohydrates and deficient in calcium, while the Masai had insufficient carbohydrates and cellulose vegetables. The ordinary meal of the Akikuyu consists of a thick porridge called "irio" and a gruel called "ucuru." Women make a special "irio" of their own that is not eaten by any males over five years of age. This dish consists of maize, legumes and plantains, to which are added green leaves and salt. Women also have a virtual monopoly of green leaves and also a weakness for edible earths and ashes.

Analysis of samples of these native dishes showed that the ordinary "irio" and "ucuru" were very low in two minerals vital to nutrition and particularly in calcium. The leaves eaten by the women were, on the other hand, very rich in certain minerals, the percentage of calcium in some being higher than that previously recorded in any natural foodstuff. Some of the edible earths were rich in iron and one special delicacy, a red millet, which is eaten before and after childbirth, contained fourteen times as much calcium and sixteen times as much manganese as ordinary millet. The significance of these discoveries lies in the effect which the larger "iron-ration" eaten by the women has upon their health, as their physique is admittedly superior to the men, while they appear to be healthier and freer from pulmonary diseases. The authors point out that improvement might be brought about by increasing the use of green vegetables by both tribes and of milk by the Akikuyu.

TROPICAL WORLD NOTES.

Tanganyika.

The heavy fall last year in the price of sisal, Tanganyika's main export crop, gravely affected Government finance and trade purchasing power. European salaries and native wages were reduced on almost all estates, operation costs were cut in every possible fashion, and a Tanganyika Sisal Growers' Association was formed, which made proposals to the local Government for financial assistance, and sent its chairman to London to investigate the possibilities of co-operative marketing and to discuss other lines of amelioration. The growers of coffee, the second most important European-grown crop, had to contend with the same difficulties that faced Kenya planters, the chief need being for temporary financial accommodation. Native coffee growing continued to expand in area and quantitative exports, though the monetary value showed a heavy reduction. Faith in the future of tea growing, particularly in the Southern Highlands, remains unshaken, but a number of Europeans in the Iringa Province were forced to discontinue their mixed farming operations, some Germans among them being repatriated.

* * *

Queensland.

The cane crop in Queensland for the 1930 season was estimated at 3,502,174 tons, which would give an approximate yield of 507,560 tons of 94 net titre, or 10,956 tons less than that made the year before. The yield of sugar from the three sugar mills in New South Wales is about 20,000 tons, which, added to the Queensland output, makes the Australian production of raw sugar, approximately 527,560 tons of 94 titre. The number of sugar mills in Queensland still remains at 35, with two refineries, one in Brisbane and one at Millaquin (Bundaberg); other sugar refineries refining Queensland sugar are situated in Sydney, Melbourne, Adelaide and Perth.

* * *

Somaliland.

According to *Colonial Report* No. 1524, the year 1930 was an exceptional one for the Colony, the rainfall being well above normal. As a result, crops have on the whole been uniformly good, grass has been plentiful, especially in the grazing areas of the western part of the country, and the stock has been in good condition throughout the year. Maize, a yellow drought-resisting Abyssinian variety, has been cultivated on a much larger scale than formerly, many plot-holders growing it over at least a quarter of their holding and a few growing it wholly in place of sorghum. Specially worthy of mention is the start made during the year in the cultivation of gram. Propaganda through headmen, and by demonstration, with the object of bringing about the cultivation of a legume in addition to, or in place of sorghum and maize, has been carried on quietly for three years. Gram has been specially mentioned as worthy of trial from the native point of view, as a local market crop and as food for stock. During the past season, several plot-holders on the better class soils have successfully grown a small crop, and applications have been made for seed for the incoming year. If this innovation becomes established, it will have a far-reaching effect on native agriculture. Amongst other improvements, it will promote soil fertility, will lead to a desire for better tillage and cultivation, will render possible a rotation of crops, make easier the introduction of a few other desirable plants, and broaden the native view of the meaning and scope of agriculture.

* * *

West Africa.

Amongst miscellaneous cultivated products grown in West Africa, the following may be mentioned. In Sierra Leone a fluctuating trade is done in ginger of which this colony exported 39,000 cwt. last year. There are prospects of further supplies from Nigeria, for samples from the south of Zaria Province have received very favourable reports. While Zaria ginger can never become a major export product, it is of interest from a railway traffic point of view, as likely to make an otherwise "dead" section of the line productive. Chillies also offer possibilities of development, for although they are grown everywhere for local use, the only important exports are from Sierra Leone, which rose to 248,000 lb. last year.

Quite recently attention has been given to the cultivation of fruit for export, and in Sierra Leone Government plantations are amassing information in regard to citrus and bananas, while the Gold Coast is to experiment with the export of crated oranges and with bananas of both the Canary and the Gros Michel types. Canning plant for the treatment of pineapples is also to be erected in the Gold Coast. Among the minor fruits, the lime offers possibilities that are being utilized by one firm in the Gold Coast, and an Imperial Institute report on samples of papain prepared in the Gambia suggests that the easily grown papaw might be turned to more profitable use than at present.

Rubber still holds a small place, and in 1929 the Cameroons exported 2,300,000 lb. to Germany, while there was a fair export of wild rubber from the Gold Coast, a source which cannot be depended upon at present market prices. The Gambia is attempting to re-establish the trade in beeswax, killed by the Health Authorities in 1921. The first exports, in 1929, amounted to only 6,500 lb., as compared with 61,500 lb. in 1909, but inquiries at the last British Industries Fair suggest an awakening interest, and last year exports rose to 12,000 lb. Another insect product that should soon rise to export grade is silk of the *Anaphe* moth caterpillar, in connection with which active and fairly successful efforts are being made commercially in suitable parts of Nigeria and the Cameroons to induce Africans to plant *Bridelia*, the favourite food of the larva, as a hedge and boundary plant.

REVIEWS.

A Textbook of Agricultural Entomology.

By K. M. Smith, Demy 8vo, xiii+285 pp., 80 figs. *Cambridge University Press*, 1931. Price 12*s*. 6*d*.

This book represents an endeavour to give an up to date account of the insect pests of farm crops and farm animals in Great Britain. Dealing as it does exclusively with the fauna of Great Britain, and having the discussion of such general topics as biological control, cultural control and climatic influence compressed into very small space, the text book is hardly likely to appeal to the tropical worker.

The introductory chapter gives an account of the organization of agricultural entomology in Great Britain; this is followed by a brief account of general methods of control, while the third chapter deals with the effect of climate on insect abundance. With chapter IV commences the systematic account of pest insects, arranged under their orders. Each important economic species receives separate treatment; of each, a description is given, together with notes on life history, symptoms of attack, distribution, host plants, means of control and a list of known natural enemies. The concluding chapter discusses the rôle of insects in the spread of virus diseases. A list of symptoms of insect attack together with the name of the insect producing them forms an appendix, and a second appendix gives a list of farm weeds with the insect pests of which they are hosts. References to literature are given at the end of each chapter.

One feels that the treatment of biological control in Chapter II is perhaps disappointingly brief and that a little more might have been made of its phenomenal success in Hawaii. Mention of Thompson's booklet on "The Biological Control of Insect and Plant Pests" (E.M.B.29) would also probably be a more useful reference on this topic than any of those furnished.

A. P.

* * *

Food Manufacture.

Publishers *Messrs. Leonard Hill, Ltd.*, 231-2, Strand, W.C. 2. Issued monthly. Annual subscription 10*s*.

This is a British Journal which records and reviews the most recent work on food preservation and which may be recommended to Departments of Agriculture interested in this subject.

The need for keeping abreast of the advances in the food preserving industry is emphasized by its possibilities, even as a side line in the tropics. During the past quarter of a century a very high standard of soundness or reliability has been reached in preserved foods and towards this improvement much has been done by Government inspection and American canneries. In the past five or six years, however, propaganda of the South Wales tin plate interests and the activities of the National Food Canning Council have served to give impetus to the canning industry of Great Britain. The National Mark of the Ministry of Agriculture is now applicable as a standard or guarantee of quality of domestic canned products. While assisting the tin-plate activities, engineering firms of repute have been investigating can making and canning process machinery and complete equipment of British manufacture is now obtainable.

The Ministry of Agriculture have co-operated with the University of Bristol to establish a fruit preservation research station at Campden, near Gloucester, of which Mr. F. Hirst, M.Sc., is Director and a series of important bulletins dealing with subjects investigated is in course of publication. Officers from the Colonies on leave desirous of becoming informed in the processing of agricultural products will find Cheltenham a suitable centre for visits to the Campden station and to several commercial canneries located in the Vale of Evesham. Long Ashton, some forty miles to westward also provides interest in its work on the preparation and bottling of fruit juices particularly cider, upon which and related subjects, Professor B. T. Barker is an authority.

It is interesting to record that American companies are extending their activities into our colonial field and recently a large pineapple enterprise has been opened up in Kenya Colony.

A. H. R.

* * *

International Address Book of Botanists.

As a result of a Resolution by the Fifth International Botanical Congress, *Messrs. Bailliere, Tindall & Cox*, 8, Henrietta Street, London W.C.2, are publishing shortly for the Bentham Trustees, the *International Address Book of Botanists*, price 13*s*., post free. This will be arranged alphabetically by countries, will be printed in the majority of cases in the language of the country in roman script, and will be provided with an Index of personal entries and Geographical Indices.

BOOKS RECEIVED.

We have to acknowledge, with thanks, the receipt of the following books which have been presented to the Library:—

Hints on Equipment and Health, by J. Kirk Balfour pp. 126. *Messrs. Bailliere, Tindall & Cox*, 3*s*. 6*d*.

Textbook of Agricultural Entomology, by K. M. Smith. pp. 287. *Cambridge University Press*, 12*s*. 6*d*.

BANANA DISEASES.

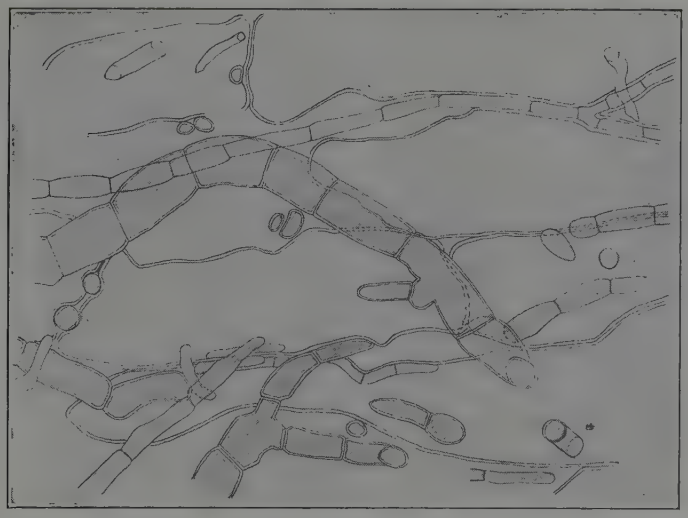

FIG. 7.
Large and abundant hyphae exploiting the flesh of cool storage fruit—(x 650).

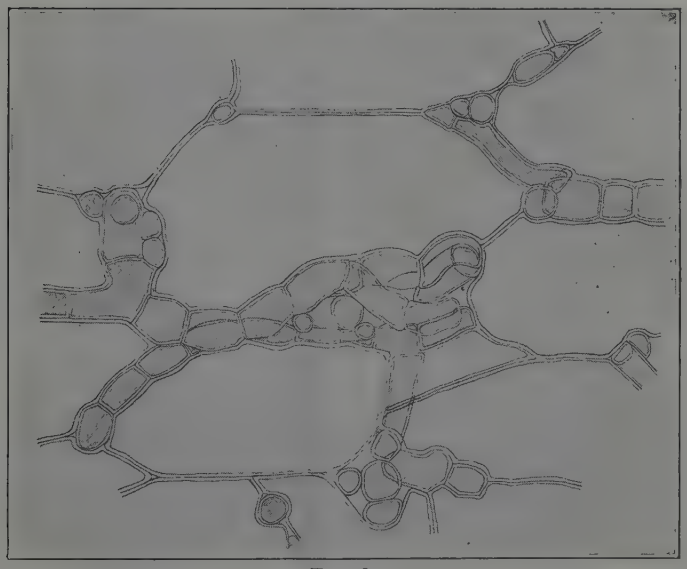

FIG. 8.
Conspicuous hyphae of "Botryodiplodia theobromae" in the tissues of the skin during infection at laboratory temperature. As before penetration is mainly in the middle lamellae; compare with Figs. 5 *and* 6 (x 650).

CACAO PROPAGATION.

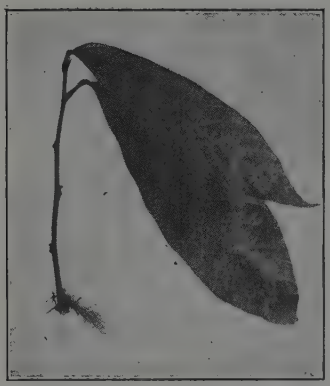

FIG. 1.

First cutting obtained by softwood propagation.

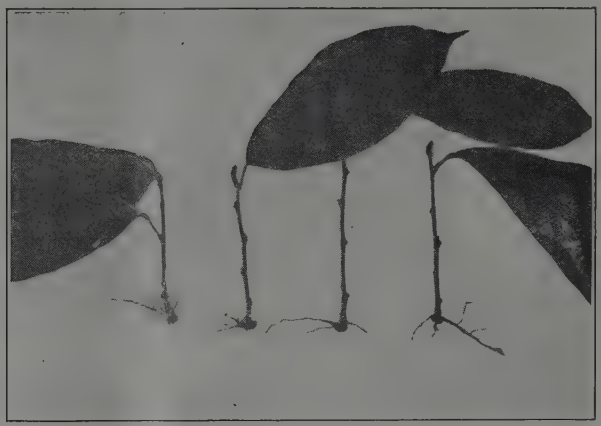

FIG. 2.

Softwood cuttings of cacao rooted in the solar propagator after 4 to 5 weeks.

FIG. 3.

Microphotograph (x 40) *of a young root formed in the stem of a softwood cutting. Note the displacement of the stem tissues.*

CACAO PROPAGATION.

The Vegetative Propagation of *Theobroma Cacao* by Softwood Cuttings.

By E. E. Pyke.

The Cacao Research Scheme of the Imperial College of Tropical Agriculture includes as part of its Botanical studies an extensive investigation of the possibilities of propagating cacao by vegetative means, more especially by those methods which will establish plants on their own roots, to enable uniform stocks to be obtained. Preliminary results obtained with softwood cuttings have been sufficiently promising to justify a brief description of the methods employed for rooting them. Further work is in progress to find whether it is possible to evolve a technique for producing rooted plants in quantity, and at a reasonable cost, from softwood material. A Solar propagator, as described by Hunter * was used for rooting the cuttings.

The most important criterion for rooting seems to be the retention of the leaves by the cuttings. The necessity for this influences both the selection of the material, and the treatment during propagation. If the cuttings suffer any appreciable water deficit or, if they are overcrowded in the propagator, the leaves tend to drop and the cuttings do not root. As the conducting elements at the cut end of the stem rapidly become blocked by exuded mucilage, and later by the overgrowth of a wound callus, uptake of water is slow; thus the water balance of the cuttings must be preserved by reducing transpiration. This is done by :—

(*i*) Selecting material which has mature leaves, and

(*ii*) keeping the air round the cuttings cool and humid.

The best material has been taken from trees which have made new growth during the dry season. These "flushes" are comparatively short and have small, quickly maturing leaves. The material was taken for rooting soon after the leaves had become mature, *i.e.*, deep green and firm, while the stems were still green. The stems should be firm and hard. Pliable, sappy stems are unsuitable owing to their tendency to rot at the ends.

The "flushes" collected were about six inches long and were cut off so as to include about two inches of the older wood at the base. They were brought from the field to the propagator in air tight tin boxes large enough to accommodate them without bending or bruising, and on setting in the rooting medium were trimmed back to the young wood by a clean slanting cut with a heavy razor, the lowermost leaf being removed in each case.

Sand was used for striking the cuttings, two samples being selected from a large number obtained from various districts in Trinidad. One was a fine brown sand with small angular grains which proved unsatisfactory, probably because of its liability to pack and become water-logged. The other, a coarser beach sand from the North-east coast of Trinidad was much better. This sand, of a round even grain, between 0.5 m.m. and 1.00 m.m. diameter, drains quickly and is very calcareous, losing about 30 per cent. by weight when leached with hydrochloric acid.

The cuttings were placed upright in the sand, about two inches of the stem being well firmed in. As the sand used dries rapidly at the surface and fails to maintain the humidity of the air above, porous pots, kept filled with water, were planted one foot apart with their bases just in, the sand. A double layer of cloth was then spread over the top and kept moist, enclosing the cuttings in a sort of tent containing a humid atmosphere.

After about three weeks in the propagator, provided the leaves had been retained, a large callus had formed on the cuttings, and several at this time had pushed out young roots from the stem just above the callus. After four or five weeks, several of the cuttings had developed abundant roots (Figs. 1, 2, and 3), and were potted up in an equal mixture of the propagating sand and compost, and hardened off in a cool frame, the leaf surface being at the same time reduced by cutting off about one-third of each leaf. The rooted cuttings, in general, showed some reluctance to put forth the new top growth required at this stage, and several eventually died without making any new leaves. The cacao shoots used seemed to possess insufficient food reserves to enable them to start afresh as virtually new individuals. It may be possible to overcome the difficulty by feeding up the parent trees before removing cuttings. Experiments are now being made with cuttings taken from young and vigorous trees grown on a well manured plot situated in the College grounds.

Note on the Anatomy of Adventitious Root Production.

The first stage in the formation of the new roots on a cutting is the activation of the cambium at the cut end of the stem into the production of callus tissue. This activity extends along the stem for a few m.m. with diminishing vigour, and gives rise to a funnel-shaped ring of tissue, known as the Lohden wedge, occupying the cambial region of the stem. In all the rooted stems of *Theobroma Cacao* examined, the new roots have arisen from this tissue. The young root starts as a small spherical tumour of growing cells in the Lohden wedge, always opposite to a wide medullary ray. It elongates and broadens, displacing the stem tissues and soon has a well marked root cap, and a vascular tract which links up with the wood and phloem of the stem. This is the stage shown in the microphotograph. (Fig. 3.) The association of the adventitious roots with medullary rays seems to be obligatory. Sometimes, some necrosis of the cambium at the cut end of the stem occurs and then, although an overgrowth of callus may form together with a new cambium, developing a Lohden wedge, the continuity with the old stem is destroyed by the layer of dead cells, and roots do not form in such a wedge.

* *Tropical Agriculture*, Vol. VIII, No. 4.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Induced "Potash Deficiency" and "Kalamati Disease" of Sugar Cane. *V. J. Koningsberger and T. H. van den Honert, in Arch. Suikerind. Ned.-Indie.*, Vol. 39 (1931), pp. 28-39.

The Kalamati disease of sugar cane is defined by Wilbrink as a stagnation or arrested growth of the young cane plants, characterized by a pale green or bronze colouration of the older leaves with more or less elongated dark red spots. The affected cane may apparently throw off the disease when the rains come, but the yield is low and there is a tendency to early death. Wilbrink showed that the disease did not occur in pot tests where potash was added to the Kalamati soil, and this result was later confirmed by field experiments.

However, certain facts in the case appeared to render doubtful the theory that the phenomenon was due to a simple lack of a particular plant food, in this case potash. The disease appeared to be confined to the Kalamati soil type, which is a laterite with considerable oxide of iron in the upper horizons of the subsoil, where anaerobic (reducing) conditions also prevail to some extent. This suggested the possibility of the presence of soluble ferrous salts under certain circumstances. Pot cultures were made in which soluble ferrous salts could be produced from free iron oxide in the presence of amonium sulphate used as a plant food. Under these conditions young sugar cane plants exhibited the symptoms of the Kalamati disease, but when the same cultures received an addition of potash the phenomena did not appear.

It thus appears that the Kalamati disease is not a nutritional disease, but is a result of iron poisoning, and that the counter action of potash represents a case of physiological antagonism by which the toxic effect of the iron is inhibited.

The Kalamati disease is more apt to be met with in the case of cane that has been heavily fertilized with amonium sulphate than where sodium nitrate is used. In the former case excess of sulphate ion may bring iron in solution.—(*Facts about Sugar*, Vol. XXVI, No. 5, 1931.)

* * *

Rate of Deposition of Latex on Porous Moulds.

The effects of pressure, rubber concentration, of latex, temperature and hydrogen-ion concentration upon the rate of deposition of latex on porous moulds, are described by H. W. Greenup, in the June number of the *Journal of Industrial and Engineering Chemistry* (1931). Pressure, rubber concentration and temperature were found to be negligible factors in comparison with hydrogen-ion concentration. By adjusting the p.H of the latex to 6.1 it was found possible to obtain aggregation of the latex particles and a marked increase in rate of deposition.

The Shape of Plots in Field Experimentation.

In the January number of the *Journal of Agricultural Science* (1931)[1], it is pointed out that:—

(1) Significant results cannot be secured in agricultural experiments only by using appropriate statistical methods; uniformity among the individual plots is more essential than anything else.

(2) Theoretical considerations suggest that the shape of the plots constitutes an important means of controlling soil heterogeneity. In accordance with these: (*a*) in no case can square plots be more uniform than long and narrow ones; (*b*) the smaller the ratio of width to length of the plots, the more uniform they are likely to be, as a rule.

In order to test the validity of the assumptions made regarding the effect of the shape of the plots, the numerical data of a number of uniformity trials have been examined by Christidis. A close agreement was found between expectation and actual results, in the great majority of cases the evidence being remarkably significant in favour of the long plots. In only three cases were the results inconclusive, this apparently being accounted for by the way in which the original plots were formed, causing an inequality in area amongst them.

Christidis therefore suggests that, in order to reduce the effect of soil heterogeneity, the plots used should be as long and narrow as possible, within the limits set by practical considerations.

* * *

Silicate Scale in Boilers.

Silicate scale in boilers causes loss through blistered tubes as well as heat losses through reduced heat transfer. Christman, Holmes and Thompson[2] have shown that silica reduction in external softening may be improved by using sodium aluminate as the coagulant. They state that sufficient soluble alumina in boiler feed water will effect precipitation in boilers as calcium or magnesium alumino-silicate. This material is flocculent and permits reduction of soluble silica in boiler water to a minimum. With sodium aluminate treatment, silicate scale is prevented through removal of silica together with hardness, rather than by removal of hardness alone.

1 B. G. Christidis, *Journal of Agricultural Science*, p. 14, 1931.

2 "Prevention of Silica Scale with Sodium Aluminate," C. H. Christman, J. A. Holmes and H. Thompson. (*Ind. Eng. Chem.*, p. 637, 1931.)

WANTED TO PURCHASE.

The Editor of *Tropical Agriculture* would be glad to hear from any reader wishing to dispose of:

(*a*) Vols. I, II, III, of the *Bulletin of Miscellaneous Information*, edited by the late J. H. Hart, Superintendent of the Botanic Gardens, Trinidad.

(*b*) Vols. V, VI, VII, of the *Agricultural Record*, official Journal of the Central Agricultural Board of Trinidad.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

The Double-Helix Crystallizer, *R. C. Pitcairn, "Facts About Sugar"* (1931) *Vol. XXVI*, p. 308.

This article takes the form of a report on the operation of a double-helix crystallizer (a superimposed type of crystallizer) during the 1930-31 crop at the Hawaiian-Philippine Company's plant, Occidental Negros, Philippine Islands. Two continuous temperature recording charts are reproduced, together with a drawing of the crystallizer.

The results of the trial may be tabulated as follows :—

A.—Average Results from Four Strikes put consecutively through Crystallizer No. 11. (Single Submerged Helix Type.)

	Temp. °F.	Brix.	Pol. %	Apparent Purity.	Sucrose %	Gravity Purity.	pH.
Massecuite into Crystallizer	136.5	95.71	53.87	56.29	56.65	19.19	6.7
Hot Molasses from Massecuite ..	—	93.46	36.77	39.34	40.48	43.31	6.7
Massecuite out of Crystallizer ..	101.75	95.78	53.14	55.48	56.17	58.65	6.7
Final Molasses from Massecuite ..	—	92.55	25.19	27.22	30.00	32.42	6.7

Time in Crystallizer—103.56 Hours.

B.—Average Results from Eighteen Strikes put consecutively through Crystallizer No. 12. (Double-Helix Type.)

	Temp. °F.	Brix.	Pol. %	Apparent Purity.	Sucrose %	Gravity Purity.	pH.
Massecuite into Crystallizer	139.06	95.36	52.36	54.97	55.00	57.74	6.7
Hot Molasses from Massecuite ..	—	93.27	36.45	39.08	39.97	42.86	6.7
Massecuite out of Crystallizer ..	102.61	95.25	51.77	54.35	54.30	57.00	6.72
Final Molasses from Massecuite ..	—	92.98	25.83	27.78	30.43	32.73	6.7

Time in Crystallizer—38.74 Hours.

In comparing these results, it must be pointed out that crystallizers Nos. 11 and 12 are in a favourable position in the factory as regards temperature conditions and that crystallizer No. 19 is not. Under these circumstances, one ton of cane per day requires 3.5 cubic feet of double-helix type crystallizer space and 10.5 cubic feetof single submerged type crystallizer space.

The following conclusions are drawn from this and previous work :—

C.—Average Results from Fifteen Strikes put consecutively through Crystallizer No. 19. (Double-Helix Type.)

	Temp. °F.	Brix.	Pol. %	Apparent Purity.	Sucrose %	Gravity Purity.	pH.
Massecuite into Crystallizer	140.87	94.88	52.37	55.19	55.12	58.09	6.7
Hot Molasses from Massecuite ..	—	93.15	36.94	39.65	40.60	43.59	6.7
Massecuite out of Crystallizer ..	106.4	95.31	51.58	54.12	54.32	56.99	6.7
Final Molasses from Massecuite ..	—	93.01	26.17	28.14	30.88	33.20	6.7

Time in Crystallizer—44.79 Hours.

1. Complete and efficient lengthwise, crosswise and vertical circulation of the massecuite in the crystallizer causes an even distribution of temperature and an even continuous growth of sugar crystal, and minimises the formation of secondary grain.
2. Partial evaporation of the water content of the massecuite while in motion during the crystallization process favourably influences the growth of the sugar crystal.
3. Even and rapid exposure of the massecuite to the air results in the rapid cooling of the massecuite.
4. Higher temperature of the massecuite at which exhausted molasses is obtained improves its drying quality at the centrifugals.
5. When desired, water or molasses can be mixed thoroughly with the massecuite in the double-helix crystallizer within a very short time.
6. The time cycle and the amount of massecuite in process are reduced materially.
7. Economy of space and equipment is secured.
8. The double-helix crystallizer can be handled by semi-skilled labour.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows: (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
2nd July ..	6 7½	10 4½
9th July ..	6 6	10 3
16th July ..	6 6	10 3
23rd July ..	6 7½	10 4½
30th July ..	6 5¼	10 3
7th August ..	6 5¼	10 2¼
13th August ..	6 3	10 0

Sugar at the beginning of July participated in the general feeling of optimism created by the Moratorium proposals, and later in the month, despite the critical financial crisis in Central Europe, an all round steadiness has been noticeable in the article. Also, there has been a period of encouraging activity in the United States when the New York market at times displayed considerable strength, the tendency being in an upward direction. The firmness has been due to the continued free distribution of Refined to Consumption, which has necessitated fresh replacements of Raw stocks on the part of Refiners, and also to the fact that holders have maintained a firm attitude and have taken every advantage of new buying movements.

* * *

COCOA.—After cocoa prices had early in June declined to the lowest level they had ever reached they gradually rose again on the strength of Mr. Hoover's announcement. Subsequently they declined on further news of political troubles in Germany, which country is the second largest consuming centre in the world. Unless, however, the situation improves in this direction prices are likely to continue on a low level. Statistically the position is strong.

* * *

COPRA.—The market has been generally steady —buyers offering £12 17*s.* 6*d.* c.i.f. usual ports. West African is offered in Liverpool at £12 12*s.* 6*d.* c.i.f.—(*West India Committee Circular*, 23rd July.)

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed remains firm while small sales of Distilled on the spot have again been made at 38*s.* *Lime Juice.*—There is no demand for Concentrated, quotations being nominal, Raw remains quiet and unchanged. —(*West India Committee Circular*, 23rd July.)

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
1st July	3¼
8th July	3 3/16
15th July	3
22nd July	3
29th July	2⅞
5th August	2 9/16
12th August	2 7/16

The market has generally been dull, and moved within very narrow limits, the fluctuations being slight. The Report of the new Dutch Committee which has been considering schemes of rubber control showed a lack of unanimity, four members being in favour of Government control and four against.

* * *

COTTON.—The following are the official Spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
26th June	5·43	8·20	16·00	32·00	14·00
3rd July	5·48	8·45	16·00	32·00	5·00-14·00
10th July	5·05	7·85	16·00	30·00	7·00-14·00
17th July	5·17	7·65	16·00	30·00	8·00-19·00
24th July	4·98	—	16·00	30·00	—
1st Aug.	4·62	—	15·00	30·00	—
8th Aug. .... (local)	4·14	—	15·00	30·00	—

The market has had a nervous undertone and the uncertainty of political developments have resulted in quick changes of sentiment while weather and cotton statistics have had, on the whole, little effect.

* * *

COFFEE.—Prices have remained fairly steady during the month of July. Fair quantities of Costa Rica and Kenya have been placed but only at a slight decline in price Kenya has sold at 78*s.*, new Santos at 44*s.* 6*d.*, and Colombian at 85*s.* Imports for the half year were 603,760 cwt. as against 658,637 cwt. and the position is deemed healthy for all fair to good coffee.

* * *

TEA.—With the end of the season prices fell to low levels in the middle of July when, however, they showed signs of recovery with arrivals of new tea supplies. Latest averages include Ceylon, 11.40*d.*; Indian, 8.19*d.*; and Java 6.35*d.*

* * *

BANANAS.—There has been a fair demand for Jamaicas during the past fortnight. Prices were advanced yesterday (July, 20th) by 10*s.* per ton to £21 15*s.*, delivered London, and £21 10*s.* delivered nearest railway station (Wholesalers). Brazilians remain unchanged at £19 per ton delivered nearest railway station.—(*West India Committee Circular*, 23rd July.)